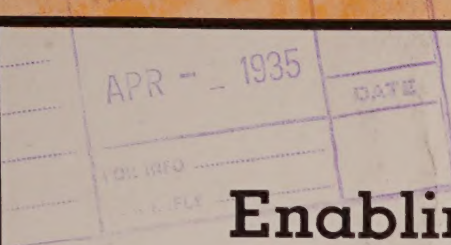


Cement MILL EDITION of Concrete

Devoted to the Manufacture,
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APRIL, 1935

400 West Madison Street
Chicago, Illinois



Enabling Legislation Is Needed

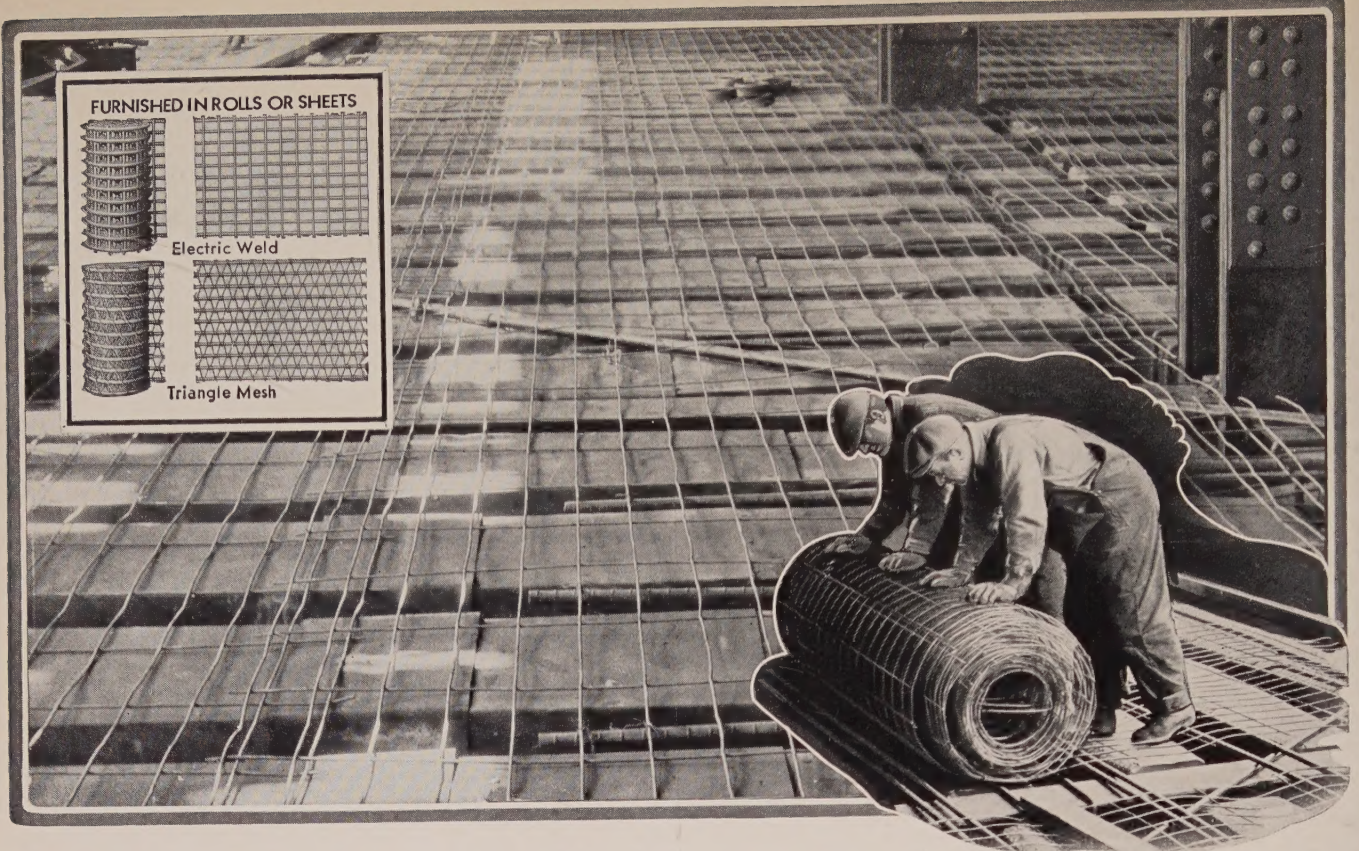
BY the time this issue of "Concrete" is in the mail the work-relief bill may have completed its course through Congress.

¶ Adoption of this great construction measure as a part of our new national policy again emphasizes the fact that only ten states—New York, New Jersey, Delaware, Maryland, South Carolina, West Virginia, Ohio, Kentucky, Michigan and Illinois—now have the necessary enabling laws to permit the formation and operation of municipal public housing authorities.

¶ Unless the remaining thirty-eight states pass the necessary enabling legislation, cities in those states will be forced to depend on the uncertain activities of private groups, with no assurance of continuity, rather than on public housing authorities duly charged with the job of initiating, constructing and managing local housing projects.

¶ Only in the ten states named will it be possible to take full advantage of the aid and co-operation to be obtained from the 450 million dollars specifically allocated in the work-relief bill to the extension of the work of the Housing Division of the PWA. There is, also, the additional sum of 900 millions made available for public projects of state and local governments.

¶ Most of our state legislatures are now in session. Organized groups in the construction industry in the thirty-eight states where no action has been taken should lose no time in building fires under the legislators.



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high yield point steel. Second—it is easy to handle, which results in low installation costs. Third—its superior quality is the result of over 100 years of wire making experience. Constantly uniform, and offering many other advantages that you will wish to know about in detail. Interesting information is available—and will be forwarded on request.

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Cement Mill Edition of CONCRETE, April, 1935. Vol. 43, No. 4. \$4.00 per year. 50c per copy. Entered as second-class matter, August 14, 1925, at the postoffice at Chicago, Ill., under act of March 3, 1879. Published monthly by Concrete Publishing Company, Chicago, Ill.

Public Utilities Dress Up with Architectural Concrete

Waukesha Pumping Stations and Water Tower Show Monolithic Concrete at Its Best—Construction Procedure, Form Work, Surface Finish

By A. P. KURANZ

Superintendent, Board of Water Commissioners, Waukesha, Wisconsin

THREE new structures—the last and largest just completed—built in recent years by the water department of the City of Waukesha, Wis., demonstrate the striking architectural possibilities of monolithic concrete even when applied to structures that are strictly utilitarian in character.

All of the structures, though located in residential areas of the city and at first violently opposed by the residents, are now regarded as definite neighborhood assets. In the

matter of economy the results obtained at Waukesha are equally gratifying.

Monolithic Concrete Pumping Stations

The first of the three structures—the Moreland Avenue pump house and reservoir shown in Figure 1—was built in 1931 as the first major unit in a city-wide plan of water-supply improvement. It added a new supply and a reservoir capacity of 150,000 gallons to the very limited capac-

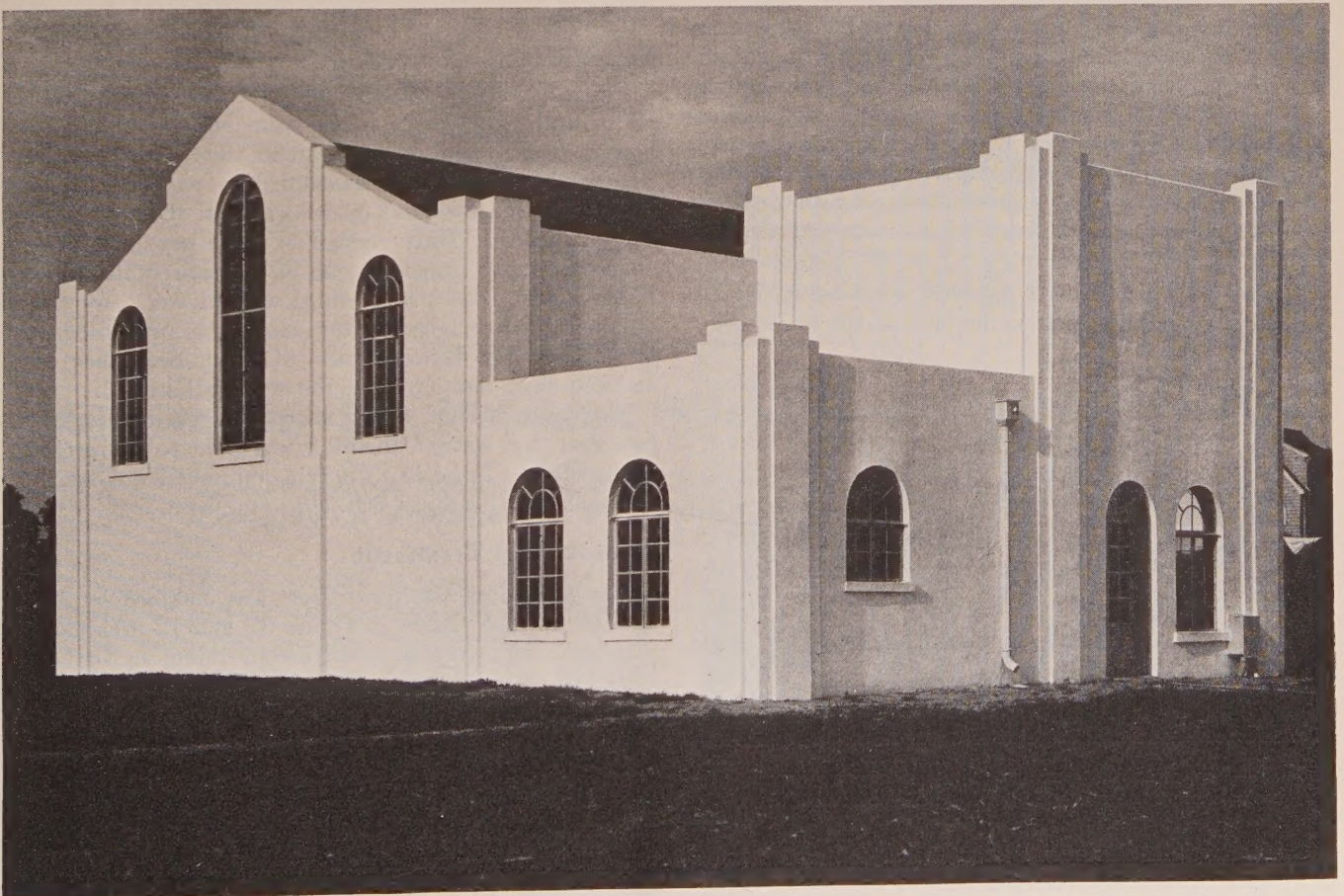


Fig. 1—Moreland Avenue pumping station and reservoir, Waukesha, Wis., demonstrates architectural possibilities of monolithic concrete for utilitarian structures

ity previously available in an old wrought iron tank. This building, like the other two projects, was built of monolithic concrete, proportioned in accordance with modern methods of concrete-making.

In this building, as well as in the Baxter Street pump house and reservoir shown in Figure 2, wood form work was used, and in both cases the concrete in the walls was placed continuously from the water line down to the footings. In each building the walls are 20 in. thick at the footings and 12 in. thick at the water line. The water line at the Moreland Avenue station is 17 ft. above the bottom. At the Baxter Street station, the corresponding height is 20 ft., although the water actually comes up only 17 ft.

Exterior Finish on Buildings

The exterior finish on both buildings was obtained with portland cement stucco. On the Moreland Avenue station the final coat contains white cement, while that on the Baxter Street station is buff-colored, with the corners and the trim around the door finished in a little darker stucco. The window sills were cast in place and also coated with stucco.

Stucco was applied in two coats—a scratch coat applied after first wetting the wall surface thoroughly, and this was followed with the finish coat of white cement stucco in the one case and buff-colored stucco in the other.

The Baxter Street station—built in 1932—provided an additional supply and a reservoir capacity of 225,000 gallons.

Architectural Concrete Water Tower

The most prominent and noteworthy of the three structures is the tower shown in Figure 3, also of monolithic concrete, and built in the late summer and early autumn of 1934. With an inside diameter of 50 ft. and an interior height of 46 ft. 1 in. to the overflow line, it adds 675,000 gallons to the storage capacity, bringing the city's elevated water storage to a point above a million gallons—more than the normal requirements of a period of 24 hours.

The tower is located on a high hill overlooking the city and the surrounding country, the base of the tower being



Fig. 2—Baxter Street pumping station and reservoir, of monolithic concrete coated with buff-colored stucco

140 ft. above the pumping station that supplies it from a deep well. This tower reservoir acts in the double capacity of a storage tank and a pressure tank. The contract price for this tower structure with equipment was

\$17,264.49, this figure representing a unit cost of 2.6 cents per gallon of storage capacity. Concrete required amounted to 545 cu. yd.

Structural Design of Tower

The tower is built in accordance with the Hewett system, in which the principal circular wall, 10 in. thick in this case and reinforced vertically on both faces with $\frac{5}{8}$ -in. rods spaced 12 in. apart, is placed under initial compression by means of horizontal steel rods placed around it and tightened with turnbuckles. Sufficient tension is put into these rods to insure the concrete being in compression when the tank is full. Around this 10-in. wall, merely as a means of protecting the steel rods, a 4-in. shell of concrete was placed, reinforced vertically with $\frac{3}{8}$ -in. round rods spaced 12 in. apart.

Build Circular Wall in Eight Sections

The principal wall of the tower—the 10-in. inner wall—was built in eight vertical sections, each section having been concreted in a continuous run in one day. A section was completed every second day, the fresh concrete being placed directly against the preceding section. No special attempt was made to obtain a bond at these vertical construction joints between sections, for the simple reason that this was not necessary. The pre-stressing of the tightened rods around the wall, as previously explained, placed the concrete under compression and this, in turn, prevented the vertical construction joint from opening.

Concrete was placed from six different levels from the scaffolding, in 4-ft. lifts. Each lift was thoroughly spaded by a crew of three men who put in all of their time on this work.

Form Work on Tower

Particular study was given to the form work for the 10-in. wall. The inside forms were built complete from bottom to top, and were sheathed tightly with shiplap. The outside forms were assembled in panels 4 ft. high and with a length equal to the width of the wall section being concreted. Only enough of these panels were provided to supply forms for one of the eight wall sections. These outside form panels, lined with plywood, were then set up in 4-ft. heights, as the concreting proceeded, and on the off day between runs of concreting, they were knocked down and moved to the next wall section.

The outer shell of 4 in. then was placed, and it was in this wall that special attention was paid to the architectural details. To begin with, this outer shell was made 10 in. thick for a height of 8 ft. above the base.

Architectural Treatment

The general architectural effect was obtained by means of a dome (not visible in Figure 3) and 12 architectural pilasters. The vertical construction joints in the outer shell fall at one edge of each of the pilasters. The form panels for this shell were also built in panels 4 ft. high, lined in this case with galvanized iron. Each panel included the pilaster mold at one end. Here, again, only enough form panels were needed to cover one of the 12 wall sections. On the off day between concreting operations the panels were taken down and moved to the next wall section. In consequence, each wall form panel was used 12 times.

A definite attempt was made to break the bond in the

vertical construction joints between the 12 sections of the outer shell, and between the outer shell and the main wall. This was accomplished by using a heavy form oil when the main 10-in. wall was built so that a noticeable film of oil was left on the surface of the concrete. A coat of the same oil was then brushed on the exposed edge of the completed section of the outer shell before the next section was concreted. This was done to prevent the formation of shrinkage cracks in the outer shell, which was thus left free to take its natural shrinkage without restraint.

Surface Finish and Lining of Tower

After the concrete had hardened in the outer shell, the exterior surface was sand-blasted to remove the form oil and to give life to the surface. The inner face of the tank (the inside surface of the 10-in. wall) was given two coats of asphalt emulsion, applied under pressure, each coat being allowed to set for a period of 24 to 36 hours. A third coat, consisting of asphalt and sand, brought the total thickness to $\frac{1}{8}$ in.

The floor of the tank is of heavily reinforced concrete 6 in. thick. The wall footing, supported on compact gravel, is 12 in. deep and 4 ft. 7 in. wide.

Proportions for Concrete

In selecting proportions for the concrete, quantities were chosen so as to obtain the necessary workability with the specified water content of $5\frac{1}{2}$ gallons to the sack of cement. The coarse aggregate was separated into two sizes. The actual proportions, which were determined by trial batches, are recorded in the table. While these quantities were employed specifically for the tower concrete, practically the same proportions were used in the Moreland Avenue and Baxter Street stations. It will be seen that the mixtures were rather heavily sanded.

Proportions for Concrete, by Weight

	Floor and 10-in. wall	Pilasters and 4-in. outer shell
Cement (1 sack).....	94 lb.	94 lb.
Dry sand	224 lb.	245 lb.
Gravel, $\frac{3}{4}$ to $\frac{5}{8}$ in.	118 lb.	105 lb.
Gravel, $\frac{5}{8}$ to $1\frac{1}{4}$ in.	148 lb.	136 lb.
Water, gross	$5\frac{1}{2}$ gall.	$5\frac{1}{2}$ gall.

Fire Insurance Rate Pulled Down

Completion of the water tower was the final factor in changing the city from sixth to fifth class fire insurance rating, thus effecting a 5 per cent reduction in rates for the business district, a saving which alone will equal the entire cost of the project in four years.

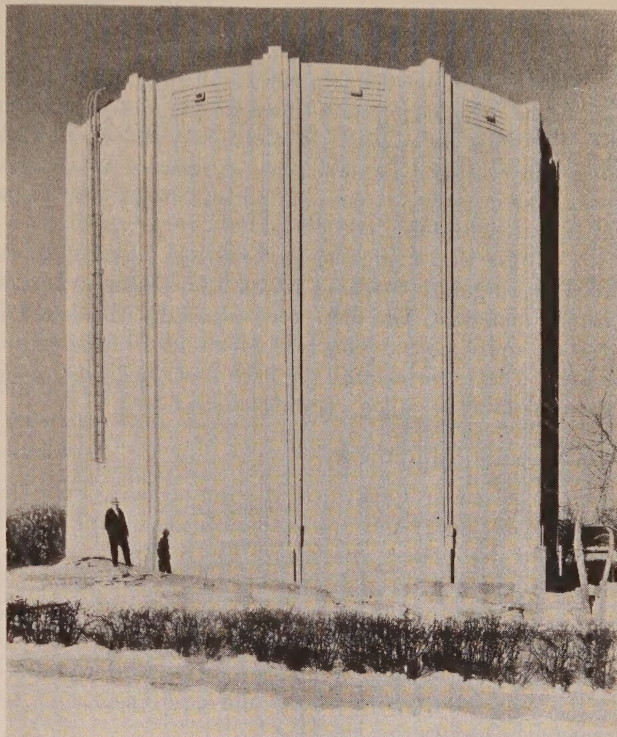


Fig. 3—Architectural concrete water tower completes Waukesha's water supply improvements

Acknowledgments: The structural features of the water tower were developed by W. S. Hewett, consulting engineer, of Chicago. Martin White, of Waukesha, was the architect, and the contractor was the Pfeiffer Construction Co., of the same city. The writer, as superintendent of the Waukesha Water Department, supervised the design and construction of the three structures here described.

Winter Paving Hastens Opening of Traffic Outlet

Heated Mixing Water, Oil-Heated Torch in Mixing Drum, and Straw Covering on Subgrade and Pavement, Tell Story of Illinois Project

CONSTRUCTION of a 40-ft. concrete pavement on a stretch of highway that includes the new highway-way grade separation structure over the B. & O. C. T. Railway tracks at Halsted Street, Riverdale, Ill., permitted early opening of this important traffic outlet from Chicago. It was possible, in this way, to open the crossing to traffic about the first of February, instead of delaying it to the spring of 1935.

The overhead highway structure was built across the railway tracks in the late summer of 1934. Work on the concrete pavement was started in late November, and was completed in the early part of January.

Early cold weather in the winter of 1934-1935 brought

mid-winter temperatures to this section of the country as early as November, so that the contractor—the Pronger Brothers Construction Co., of Blue Island, Ill.—had to deal with winter weather conditions from the beginning.

Winter construction methods were, accordingly, adopted. To begin with, the subgrade was covered with straw, to prevent excessive frost penetration, as soon as it was rolled. Just prior to the placing of a run of concrete, the straw was removed from the subgrade, and along with it came a certain amount of mud and slush. The mud removed was replaced with cinders, which were rolled to the proper subgrade level. As soon as possible after the

(Continued on page 8)

Test Adhesion of Stucco to Concrete Block

Strength of
Bond Exceeds
Tensile Strength
of Stucco

By J. H. LUCAS

Associate Professor of Highway Engineering
Georgia School of Technology, Atlanta, Ga.

THE development of a novel testing rig was required when recently certain interests requested that the materials laboratory at Georgia School of Technology investigate the adhesion of stucco to concrete block. No records of previous parallel tests were found that suggested suitable equipment.

The people who instigated the tests had in mind an extended investigation covering adhesion of stucco to several masonry materials, but they were especially interested in a certain quite porous concrete block of Florida manufacture. The experimental rig here described was made, and two 5 by 6 in. stucco samples were tested.

The Testing Equipment

The yoke and grid shown in the line drawing consisted of four $\frac{1}{4}$ -in. steel bars, two of them fastened with double nuts to the side plates, which were $1\frac{1}{2}$ in. high. The two end bars extended through the side plates and fitted into holes in the ends of the strap-iron yoke pieces. The yoke is fastened by a chain to the movable head of a tension machine during testing, so the tension is well equalized. The halftone illustration shows the equipment and test specimen in the testing machine.

Two grids were made and two samples of stucco were placed in the block. A cement-sand mixture of stucco, proportioned 1:3, was used with sufficient water to approximate stucco workability. The block was well wetted before placing the samples. Wood end pieces were fastened to the grid with twine, and the side plates were wedged up slightly from the block with wood strips that were removed after making the specimens. It was feared that if the steel side plates rested directly on the block, shrinkage of the stucco would break it loose from the block

before testing. The stucco was troweled flush with the top of the sides of the grid and the samples were cured in a moist closet for 28 days.

When the first specimen was broken the block was fastened to the base of the testing machine with chains around bars through the holes in the block. When the second specimen was broken at 56 days, the webs of the block failed in tension. Square steel bars across the block at the edges of the stucco sample were then used in chaining the block down.

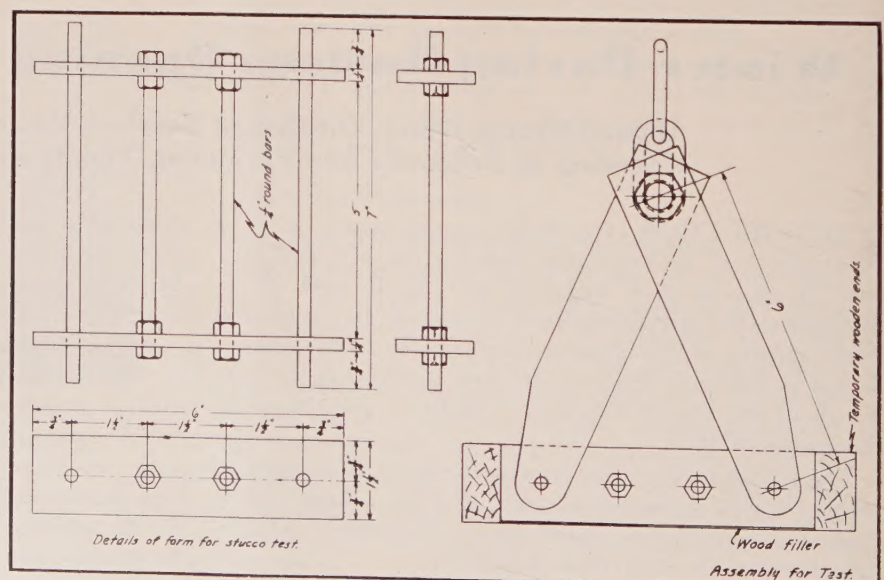
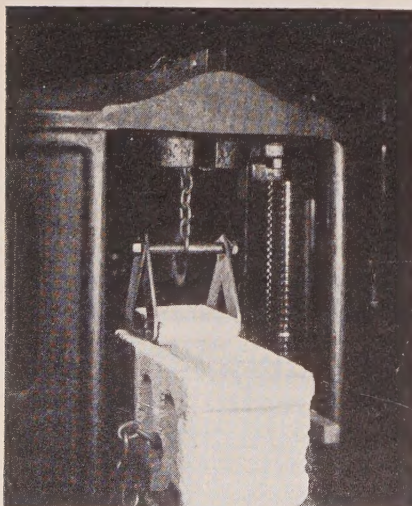
Bond Strength Exceeds Tensile Strength

In both cases the stucco specimen failed apparently in tension at the plane of the steel bars. The 28-day specimen failed with a total tension of 1,860 lb., or 62 lb. per sq. in. average unit tension. The 56-day specimen failed with a load of 1,760 lb., or 58.7 lb. average unit tension.

From the fact that these average unit tensions are quite low compared to the usual tensile strength of 1:3 mortar, it is probable that flexing of the $\frac{1}{4}$ -in. bars permitted quite high unit tension along the edges of the specimen before tension of any magnitude developed at the center, and that failure was progressive from the edges toward the center. However, for the purposes of this investigation, the tensions at the plane of the bond are equal to those at the plane of the steel, so it may be said that the bond of the stucco to the block exceeds the tensile strength of the stucco. If the area of the bars, which constitute $\frac{1}{6}$ of the section area, is deducted, it may be said that the adhesion of the stucco to the block exceeds $\frac{5}{6}$ the tensile strength of the stucco.

Additional tests of stucco on a variety of masonry materials are now planned by the laboratory.

Testing adhesion of stucco to concrete building block. At left, testing equipment and specimen in testing machine. At right, details of testing equipment



Light-Weight Slag Concrete Develops High Strength

Lehigh University Tests Reported by Prof. Lyse—Excellent Fire-Resistant Qualities Also Shown

A REPORT by Inge Lyse in the September-October *Journal* of the American Concrete Institute, printed under the heading of "Lightweight Slag Concrete," describes a series of tests made during an investigation conducted at the Fritz Engineering Laboratory, Lehigh University, in October and November, 1933. The author is research associate professor of engineering materials at Lehigh University. His report deals with a porous slag produced by a special process for water-cooling ordinary blast-furnace slag.

Professor Lyse points out that the light-weight concrete field is one through which a considerable economic gain may be made, and because of this, a large number of methods of producing light-weight concrete have been developed during the last few years, both in this country and abroad, particularly in Germany. Other desirable features which often accompany light-weight concretes are improved heat and sound insulations. The light-weight concrete thus becomes a very important part of our reinforced concrete construction, particularly building construction, and more data on this material are very much needed.

Blast-furnace slag has been used successfully as concrete aggregate for a number of years, and tests have shown that the slag concrete is in no way inferior to concrete containing other aggregates. A very complete and thorough review of our present knowledge of slag concrete is contained in a report by Committee 201, on Aggregate Specifications for the American Concrete Institute, published in the October (1930) *Journal* of the A. C. I.

In the fall of 1933 the Republic Fireproofing Co., New York, producers of the slagblok floor system, requested Lehigh University to investigate light-weight slag mentioned above, as coarse aggregate. This slag had a considerably lower unit weight than did the air-cooled slag—47.2 lb. per cu. ft. loose measure. The chemical analysis of the slag was:

Element	SiO ₂	Al ₂ O ₃	CaO	MgO	Fe ₂ O ₃	MnO	S
Per Cent	34.70	11.74	30.68	17.76	1.20	0.95	1.26

The purpose of the investigation was to obtain reliable information as to the qualities of the concrete containing this porous slag and compare the results with tests on gravel concrete.

The Test Program

The original program for this investigation is summarized in the accompanying tabulation.

TABLE 1—THE TEST PROGRAM

Group	Kind of Aggregates	Concrete Mixes	Kind of Tests
1	Sand and Coarse Slag Sand and Gravel	Variable	Compression, Modulus of Elasticity
2	Sand and Coarse Slag Sand and Gravel	1:2½:3½	Compression, Flexure, Bond, Diagonal Tension, Modulus of Elasticity

The major part of the program was in Group 2, which

included tests on a number of qualities of the concrete at 7 and 28 days. The other group was considered an auxiliary test. In Group 2 the consistency of the concrete was designed for a slump of 5 to 7 in., both for the slag and the gravel concrete.

In addition to the above outlined investigation, tests are now in progress on the durability of the 1:2½:3½ concrete mix containing slag or gravel as coarse aggregates. The durability is measured in terms of loss in weight due to repeated freezings and thawings.

Test Specimens

Standard 6 by 12-in. cylinders were used for all the compressive strength tests, for the determination of the modulus of elasticity, and for the tests of bond strength. The bond specimens had a ¾-in. diameter reinforcing bar embedded for the full 12 in. in 6 by 12-in. cylinders. The modulus of rupture or the flexural strength was determined on 7 by 10 by 36-in. plain concrete beams. Diagonal tension strength was secured from tests of 7 by 10 by 36-in. beams with longitudinal but no web reinforcement. Standard procedure of making, curing and testing was followed.

Testing Procedure

Trial mixes were used for the determination of the water content necessary for the desired slump of the concrete. The proportioning of the concrete was done by weighing out the amount determined from the unit weight values. The mixing was done by ordinary methods in a machine mixer. The consistency of the concrete in Group 2, which included the study of the 1:2½:3½ mix, corresponded to a slump for the slag concrete between 5 and 6 in., and for the gravel concrete between 6 and 7 in. The specimens were cured in the moist room and tested at the ages of 7 and 28 days. For compressive, flexural and diagonal tension strengths, the tests were made in a 300,000-lb. capacity Olsen testing machine. The bond specimens were tested in a 50,000-lb. capacity Riehle machine. The bond at initial slip of the bar was taken at a measured deformation of 0.001 in.

High Strengths Obtained

The uniformity in results was very good for all the tests included in the investigation. Both the slag concrete and the gravel concrete increased in strength very regularly with the increase in cement content in the paste. For 7-day tests the slag concrete was slightly greater in strength than was gravel concrete of the same quality paste. At the age of 28 days both concretes gave nearly the same results for ordinary strength, while for very great strength the gravel concrete gave slightly higher results than did the slag concrete. These results indicate that concrete of nearly any desired strength may be obtained with slag as well as with gravel aggregates. Light-weight aggre-

gates often produce concrete having considerably lower modulus of elasticity than gravel concrete. This unfortunate behavior was not found for the slag concrete, the modulus being nearly the same for slag and gravel concretes of the same strength. Modulus of elasticity determination of these concrete mixes showed that the modulus increased regularly with the increase in compressive strength. Attention should be given to the fact that the modulus both for slag and gravel concretes followed nearly the same trend.

The summarized results of the investigation of the 1:2½:3½ mix are given in Table 2. The fine aggregate was natural sand and the coarse aggregate was either slag or gravel.

TABLE 2—SUMMARY OF TEST RESULTS

Kind of Coarse Aggregate	Age Days	Compression	Average Results, p. s. i.			
			Initial Bond	Flexure	Diagonal Tension	Modulus of Elasticity
Slag	7	2,300	404	446	193	2,275,000
	28	3,740	708	545	233	3,520,000
Gravel	7	2,250	438	414	183	2,430,000
	28	3,760	742	554	255	3,880,000

The diagonal tension strength was obtained on beams reinforced against failure in flexure. The type of failure given by these beams was typical of such failures.

Discussion of Results

The sand-coarse ratio had to be at least 40-60 for slag aggregates to produce a smooth and placeable concrete. With placeable mixes the results showed that the strength of the concrete was approximately the same for concrete having either slag aggregates or ordinary gravel aggregates. This was true for compressive strength, bond, flexure, and diagonal tension, as well as for modulus of elasticity. The weight of the 1:2½:3½ concrete mix having slag as coarse aggregate was approximately 127 lb. per cu. ft. in saturated condition. When dried to constant weight at a temperature of approximately 100 deg. C., the average unit weight was 113 lb. per cu. ft. The yield of

the 1:2½:3½ slag concrete was about 6.00 sacks of cement per cubic yard of concrete.

The investigation showed that water-cooled light-weight slag concrete can be made of as high strength quality as that of ordinary gravel concrete.

Insulation Quality

Carl A. Menzel, in his recent report on "Tests of the Fire Resistance and Strength of Walls of Concrete Masonry Units," published by the Portland Cement Association, January, 1934, presents data helpful in judging the insulating quality of water-cooled porous slag. Mr. Menzel's report shows clearly how the porous light-weight concretes containing water-cooled slag have a much higher fire resistance than have calcareous and silicious aggregates. These data would indicate that water-cooled slag would be an excellent material for the production of heat and sound-insulating concrete. Further experimentation is needed on this important problem.

Conclusions

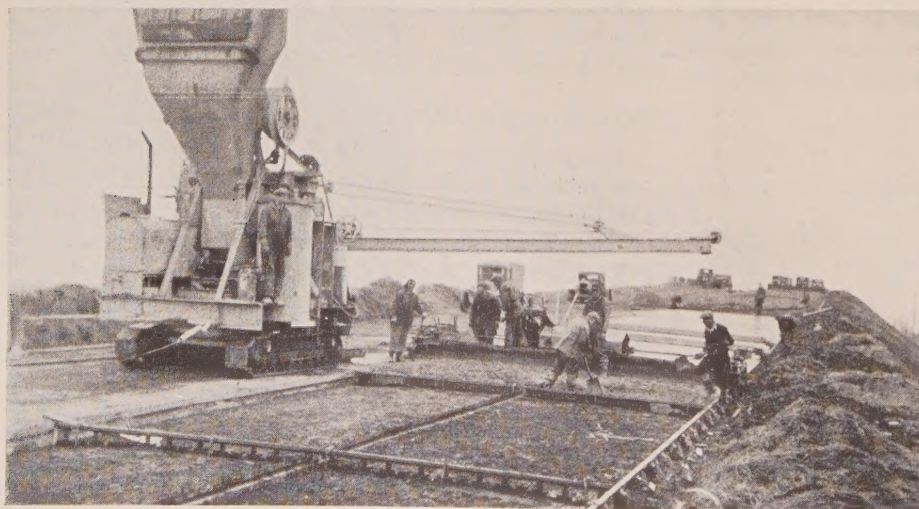
The results obtained indicate that:

1. Porous slag with the proper sand content will give placeable concrete mixes.
2. The weight of the concrete having sand and coarse slag as aggregates was considerably less than the weight of ordinary concrete. The dry weight being only 113 lb. per cu. ft.
3. The yield was less for slag concrete than for gravel concrete.
4. The compressive, bond, flexural, and diagonal tension strengths of the concrete were very nearly the same for slag and for gravel aggregates.
5. The modulus of elasticity of the concrete increased with the increase in compressive strength and was approximately the same for slag concrete and for gravel concrete.
6. Menzel's fire tests show an excellent fire-resisting quality of light-weight concrete having water-cooled slag aggregate.

WINTER PAVING

(Continued from page 5)

concrete was placed and finished, it was covered with straw and kept covered until the pavement was ready to be opened to traffic.



A departure from more usual winter concreting practice was permitted in the matter of heating the concrete materials—a departure that aided materially in holding down the additional cost of cold-weather paving. Instead of pre-heating all concrete materials, only the mixing water was pre-heated. This was accomplished by a portable hot water heater at the side of the mixer. An oil-heated torch, however, was turned into the mixing drum, and by this means it was possible to place the concrete at a minimum of 60 deg. F.

This winter paving project was under the jurisdiction of the Illinois Division of Highways, of which Ernest Lieberman is chief engineer. W. A. Reinert was resident engineer, representing the Division of Highways.

This view, taken on January 9, shows winter paving work at Riverdale, Ill., a suburb of Chicago. Straw coverings protected the subgrade and the finished pavement

Facts About Ready-Mixed Concrete

Association Conducts Survey of Type of Operation, Kind of Equipment, Size of Plant and Capital Invest- ments—Literature Available

ENGINEERING literature on the production and use of ready-mixed concrete, and tests of this material, is for the most part of a scattered and fragmentary character. Readers of CONCRETE who are interested in the subject, either as users or producers of ready-mixed concrete, may obtain the following printed pamphlets and mimeographs from the National Ready-Mixed Concrete Association, 545 Munsey Building, Washington, D. C. The first four on the list are printed pamphlets; the others are mimeographs.

P. 1. *Estimating Quantities for Concrete*, by Stanton Walker, Director of Engineering of the National Ready-Mixed Concrete Association. Price 25 cents.

P. 2. *The Proportioning of Concrete for Strength, Durability and Impermeability*, by A. T. Goldbeck, Director, Bureau of Engineering, National Crushed Stone Association. Price 25 cents.

P. 3. *A Concrete Story in a Concrete Way*. Excerpt from paper by Cloyd M. Chapman, Consulting Engineer, New York City, published by Guaranteed Concrete Company, St. Paul, Minn. Single copies free.

P. 6. *Tentative Specifications for Ready-Mixed Concrete*, of the American Society for Testing Materials, Serial Designation C 94-33 T. Reprinted by the National Ready-Mixed Concrete Association. Price 15 cents.

M. 1. *Strength Specifications for Ready-Mixed Concrete*, by J. L. Shiely, J. L. Shiely Company, Inc., St. Paul, Minn. Price 15 cents.

M. 2. *Central Mixed Concrete in Philadelphia*, by H. J. Whitten, Warner Company, Philadelphia, Pa. Price 15 cents.

M. 3. *Effect of Haul on Strength of Concrete*. Summary of results of tests, carried out by J. L. Shiely Company, St. Paul, Minn., showing strength of cylinders taken from concrete at plant and from same batch after haul about 12 miles in agitator truck. Price 5 cents.

M. 4. *Effect of Period of Agitating Ready-Mixed Concrete*. Summary of results of three comprehensive series of tests carried out for the Boston Concrete Corporation by the Thompson and Lichtner Company, Inc., under the supervision of Miles N. Clair. Gives strengths and slumps of concrete hauled in open-top agitator and in closed-drum agitator up to 3 hours. Price 25 cents.

M. 5. *Bibliography on Ready-Mixed Concrete*. List of literature on ready-mixed concrete, for the most part from current periodicals, covering period from 1911 to August 1, 1933. Price \$1.00.

M. 6. *Some Requirements of a Purchase Specification for Ready-Mixed Concrete*, by R. B. Young, Consulting Engineer, Toronto, and Vice-President of Association. Price 25 cents.

M. 11. *Use of Cement in Bulk*. Letter reviewing report of American Concrete Institute Committee 607 on the use of bulk cement, published in the September (1931) *Journal of the A.C.I.* The letter includes a "Selected Bibliography on Handling Bulk Cement," which forms a part of the report. Price 10 cents.

M. 12. *Specification for Transit-Mixed or Central-Plant-Mixed Concrete*, prepared by public works department of a large city, issued in 1931. Price 5 cents. Specification covers mixing and transporting, delivery, quality, field tests and damages. Issued in 1931.

M. 15. *Preliminary Report on Questionnaire to Ready-Mixed Concrete Operators*. Questionnaire concerning type of operations, kind of equipment, sizes of plant, methods of operation and control sent to about 300 companies. Sixty-eight companies returned answers. Report gives only more easily summarized data. Price 5 cents.

M. 16. *A Specification for Ready-Mixed Concrete*, by R. B. Young, Consulting Engineer, Toronto, Canada and Vice-President of the Association. Price 25 cents.

M. 17. *Use of Ready-Mixed Concrete in Cold Weather*, by Miles N. Clair, Vice-President and Treasurer, Thompson & Lichtner Company, Inc., Boston, Mass. Price 25 cents.

M. 18. *Future Markets for Concrete*, by W. D. M. Allan, Portland Cement Association, Chicago. Stresses importance of small-user market. Price 15 cents.

M. 21. *Control Tests of Ready-Mixed Concrete*, by Miles N. Clair, Vice-President and Treasurer, the Thompson & Lichtner Co., Inc., Boston, Mass. Stresses importance of control of quality of ready-mixed concrete as affected by moisture content, grading of aggregate, etc. Gives data on comparisons of measured and calculated volume of concrete. Price 20 cents.

Survey of Industry

One of the above publications, designated as M-15 and headed "Preliminary Report on Questionnaire to Ready-Mixed Concrete Operators" deserves detailed mention. This survey of the industry was conducted by a committee representing the National Ready-Mixed Concrete Association. Although the report was written in 1933, the facts disclosed are as applicable now as they were then.

In order to develop information concerning the type of operation, kind of equipment, sizes of plant, methods of operation and control, a questionnaire was sent to all ready-mixed concrete operators in the United States and Canada. It was sent to a list of 300 companies. The questions were prepared with the co-operation and advice of several engineers and operators. Such returns as have been received give promise of yielding valuable information.

Only 68 of the 300 companies returned answers to the questionnaire. This percentage of returns is not out of line with usual experience in work of this nature. Further follow-ups would undoubtedly fill up many of the gaps. Of the 68 companies, 28 operate central mixing plants, 33 operate batching plants in connection with truck mixers, and 7 handle both types of operations. The 28 central-mixing-plant companies operate 34 plants; the 33 truck-mixer companies operate 44 batching plants; and the 7 companies with both types of operations have 9 plants. In consequence, 87 plants are represented in the replies.

Average Population Served

The population within economical haul was 6,700,000 for the 28 central-mixing-plant companies, 10,400,000 for the 33 truck-mixing companies, and 5,400,000 for the 7 dual type operations. The reported eight-hour capacity for the central mixing plants was 13,430 cu. yd., or an average of 400 cu. yd. per plant; for the batching plants the corresponding figures are 11,835 cu. yd. (only 41 plants reporting), or an average of about 290 cu. yd. per plant; and for the dual operations 2,810 cu. yd., or an average of 310 cu. yd. From these data it may be said that 1 cu. yd. capacity per eight-hour day is serving in the neighborhood of 700 to 800 people. It also appears that each central mixing plant served an average population of about 300,000, and each batching plant one of about 240,000.

The information on the normal operating force of the plants was too incomplete to attempt a summary. Evi-

dently many of the companies reported only those men working at the plant, and left out of account their truck drivers, etc., while others included the entire personnel.

Size of Capital Investment

Information received with reference to the investment was most incomplete. Several companies gave no information on this score, and a greater number gave indefinite information. This latter condition resulted from different causes—trucks were rented, land was leased, or there was no investment in plant facilities.

Investment figures of varying completeness were given by 24 central mixing companies. The total of the figures was \$2,159,000. These same companies reported an eight-hour capacity of 10,780 cu. yd., indicating an investment of almost exactly \$200 per cu. yd. capacity per eight-hour day. What appeared to be fairly complete information was furnished by 14 companies. These showed an investment of \$1,464,000 for an eight-hour capacity of 6,255 cu. yd., or \$225 per cu. yd. per eight-hour day capacity.

Similarly incomplete information was furnished by companies operating batching plants. An investment figure (including both incomplete and complete returns) of \$3,589,000 was reported for 30 companies having an

eight-hour day capacity of 11,435 cu. yd. This indicates about \$310 per unit of capacity. This figure is so out of line with that for central mixing plants that it suggests a further analysis of the figure is necessary before too much dependence is placed on it. What seemed to be fairly complete information was furnished by 20 companies with an investment of \$2,968,000 and a capacity of 8,135 cu. yd. This indicates \$365 per unit.

Mixers and Trucks

No very helpful information was obtained concerning the size of the mixer used in the central mixing plants. The 28 companies with 34 plants reported the operation of 39 mixers. Many of them omitted information concerning the capacity of the mixers, but the two and three-yard sizes seem to predominate, with the two-yard being the more common. The use of 374 trucks was reported by 23 of the 28 central mixing companies. It should be pointed out that this figure includes one company reporting the operation of 90 dump trucks. The 33 batching plants reported the use of 280 trucks, with the 2½ to 3½-yd. capacities predominating. The 7 companies handling both types of operation indicated the use of 66 trucks, with sizes of 3-yd. capacities and larger predominating.

Concrete Burial Vault Manufacturers' Meeting to Cover Wide Scope of Subjects

Advance Reports Indicate Good Attendance at Coming Convention in Cleveland—Leaders of Industry See Growth Ahead

EFFORTS toward a broader and better understanding between the government, manufacturer and funeral director in the sale of concrete burial vaults will be emphasized in the program planned for the annual convention of the National Concrete Burial Vault Association to be held at the Statler Hotel, Cleveland, Ohio, on April 24 and 25.

Papers and talks on manufacturing, sales promotion and advertising will be presented. The NRA code of the industry, as well as the Federal Trade Commission conference, will be covered by individuals in constant touch with the governmental offices.

An outstanding feature of the convention is the attention that is going to be accorded the ladies attending with the men. The local Cleveland manufacturers have surprises in store for all those attending. The scope of subjects as well as social affairs may be seen from the program:

Wednesday Morning, April 24

8:30-9:30—Registration.

9:30-12:00—Invocation.

Address of welcome by Hon. Harry L. Davis, mayor of Cleveland.

Response by President Ross Hilles.

Report of Secretary-Treasurer J. H. Stuart.

Election of directors and officers.

Appointment of committees.

Code discussion, by L. A. Chick.

(Ladies will meet after address by Mayor Davis in Parlor 3 on the mezzanine floor.)

Wednesday Afternoon, April 24

1:15-2:00—Report on house-organ advertising, by E. C. Jeffries; followed by discussion.

2:00-3:00—Talk on advertising, by F. H. Van Ness; followed by discussion.

3:00-3:30—Report of membership committee, by H. A. Dahlquist.

7:00-9:00—Banquet, Lattice Room, Statler Hotel; Ralph W. Mead, toastmaster.

Thursday Morning, April 25

9:30-10:00—Burial Protection from the Funeral Director's Viewpoint, by J. Edward Cochran.

10:00-10:30—Burial Protection from the Cemetery Viewpoint, by L. DeWald, commissioner of cemeteries.

10:30-11:15—Sales talks by C. E. Berg, L. K. Huber, F. A. Washburn, H. E. Coburn and J. F. McCloskey.

11:15-12:00—Motion pictures—Vault Manufacturing, by F. H. Van Ness.

Thursday Afternoon, April 25

1:15—"The Durability and Permanence of Five-Gallon Concrete," by P. M. Woodworth, technical engineer, Portland Cement Association.

Entertainment for the ladies on Wednesday has been arranged by E. C. Jeffries and Ralph W. Mead, Cleveland committee members.

The concrete burial vault industry is another of our younger manufacturing groups having a growing future ahead. Vault manufacturers everywhere, whether or not they are members of the National Concrete Burial Vault Association, are urged to attend this gathering and to become affiliated with the association. Only through the combined efforts of all manufacturers in this special field can the future of the industry reach its highest level.

Compares Curved and Straight Beams of Rectangular Cross-Section

By R. P. V. MARQUARDSEN
Registered Structural Engineer, Harvey, Illinois

THE writer recently has had occasion to determine theoretically the ratio of the critical stress in a homogeneous curved beam to that in a homogeneous straight beam of identical rectangular cross-section when subjected to the same direct force and bending moment; and, thinking that the result obtained might be of some value to others, he desires to pass it along.

The Problem Stated

In Figure 1, at (a), is shown an infinitesimally short length of curved beam of unit width on which is applied an eccentric force N at a distance e from the center of the section. If we assume that two forces N' and N'' , equal in magnitude (and each equal to N) but opposite in direc-

the figure, the direct force N'' will cause equal tensile unit stresses in all fibers and the bending action of the couple $N' - N$ will be reversed.

It can be shown, although the proof will not be given here, that the unit stresses in the upper and lower fibers

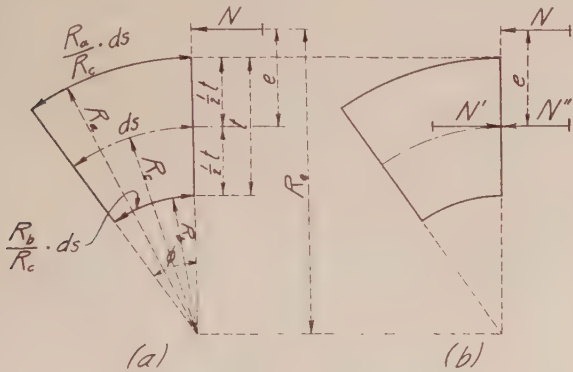
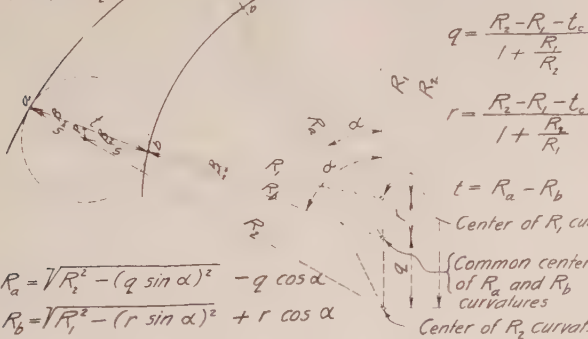


Fig. 1

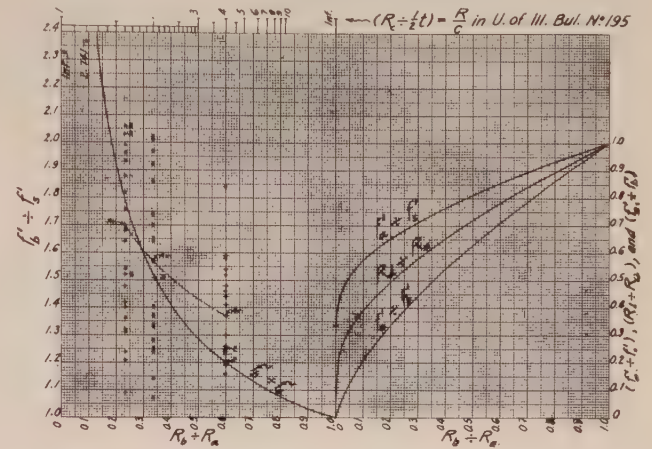
Fig. 2

Suggestion:

$$\frac{s}{p} = \frac{R_1}{r} = \frac{R_2}{q}$$



tion, are applied at the center of the section as indicated at (b)—and this, of course, would not destroy the equilibrium nor change the internal stresses—we have acting on the section a couple $N' - N$ causing pure-bending stresses whose moment is $e N$ or $e N'$, and a direct force $N'' (= N)$ applied at the center, causing equal compressive unit stresses in all fibers. It should be noted that, if the eccentric force N acts in a direction opposite to that shown in



(f_a and f_b respectively) may be found by applying the following formulas (if we assume that Hooke's Law holds and that a section plane before bending remains plane after bending):

$$f_a = \frac{N}{t} \cdot \left(1 \pm \frac{2 (R_a - R_d) e}{R_a (R_a + R_b - 2 R_d)} \right) \dots \dots (1)$$

$$f_b = \frac{N}{t} \cdot \left(1 \pm \frac{2 (R_d - R_b) e}{R_b (R_a + R_b - 2 R_d)} \right) \dots \dots (2)$$

in which

$$R_d = \frac{R_a - R_b}{\log_e R_a - \log_e R_b} \dots \dots \dots (3)$$

For a straight beam of unit width, the unit stress, f_s , in the upper and lower fibers (using the same nomenclature) may be expressed as follows:

$$f_s = \frac{N}{t} \cdot \left(1 \pm \frac{6 e}{R_a - R_b} \right) \dots \dots \dots (4)$$

In formulas (1), (2) and (4) the quantity $N \div t$ times 1 represents the fiber stress due to the direct force applied at the center of the section, and the remainder of each equation represents the fiber stress due to the bending moment. The fiber stress due to the direct force is the same in all three formulas and therefore may be neglected in comparing the critical fiber stresses.

Designating the fiber stresses due to the bending moment by a prime (i.e., f'_a , f'_b , and f'_s) and using the values given in formulas (1), (2), and (4) we find that—

$$\frac{f_a'}{f_b'} = \frac{R_a - R_d}{R_d - R_b} \cdot \frac{R_b}{R_a} \dots\dots\dots (5)$$

$$\frac{f_a'}{f_s'} = \frac{R_a - R_d}{R_a + R_b - 2 R_d} \cdot \frac{R_a - R_b}{3 R_a} \dots\dots\dots (6)$$

$$\frac{f_b'}{f_s'} = \frac{R_d - R_b}{R_a + R_b - 2 R_d} \cdot \frac{R_a - R_b}{3 R_b} \dots\dots\dots (7)$$

These three ratios, as well as the ratio of R_d to R_a , are shown graphically in the accompanying diagram. As a matter of curiosity and for the sake of comparison, the findings of Seely and James with respect to the ratio of $f_b' \div f_s'$, as reported in Bulletin No. 195 of the University of Illinois, are added, the averages of their three rectangular-section series ($R_c \div \frac{1}{2} t = R \div c = 1.6, 2.0$ and 4.0) being connected with a dotted curve.

Curved Beams of Variable Section

The foregoing discussion is based on the R_a and R_b curvatures having a common center, which of course is only true when the curved beam is of constant section. To be able to use the formulas and diagram developed for curved beams of constant section in connection with curved beams of variable section, it will be necessary to find proper values of R_a and R_b for each section it is desired

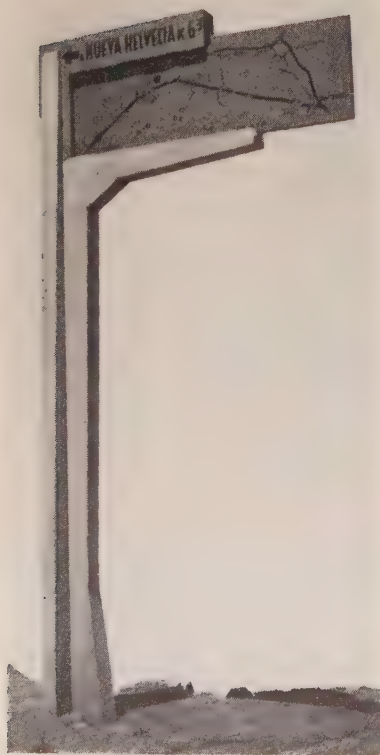
to investigate, before the formulas and diagram can be employed.

In Figure 2 is indicated a solution to this problem. As may be seen, the common center of the R_a and R_b curvatures falls on a line connecting the centers of curvature of the intrados and extrados radii (R_1 and R_2 , respectively) and is located a distance r from the center of the R_1 curvature, the formula for calculating the value of r being given in the figure. It should be noted that t_c in the formula is the thickness of the curved beam on the line (produced) connecting the centers of the R_1 and R_2 curvatures and is based on R_1 and R_2 being constants. If R_1 and R_2 do not actually remain constants until this line is reached, t_c must be based on the R_1 and R_2 curvatures of the section under consideration being extended to the line (produced) connecting the centers of the R_1 and R_2 curvatures.

The common center of the R_a and R_b curvatures having been located, the values of R_a , R_b , and t for any section under consideration can perhaps be found more quickly by scaling than by applying the formulas given in the figure.

It should be borne in mind that the ratios shown in the diagram are for critical *bending* fiber stresses only. If it is desired to find the ratio for critical *total* fiber stresses, the *direct* fiber stress ($N \div t$) should be added (or deducted, as the case may be) to the two bending fiber stresses, before the curved-beam fiber stress is divided by the straight-beam fiber stress.

Precast Concrete Highway Post Shows Location



Precast concrete highway sign post shows motorist where he is and where he is going

A PRECAST concrete highway sign post that shows the motorist where he is and where he is going has become a novel feature of the highway system of Uruguay.

Study of the illustration shows the general design of the post, which has two horizontal arms, or cantilevers, near the top, between which a precast reinforced concrete slab is held. This precast slab, upon which the map is stencilled, is only about $1\frac{1}{8}$ in. thick. Its height is 16 in. and its length 39 in. The slab is painted with "duco" in several colors, after first being treated with three baths in a chem-

ical solution which gives it a glazed surface. The painting is done by stencilling with an air brush.

The slab containing the map slides into V-shaped grooves and is held in place with a small amount of cement, so it can be removed for repainting when necessary.

The post itself is a T-shaped section 9 ft. high, set about 1 ft. 8 in. into the ground. The section measures $11\frac{3}{4}$ in. each way at the base (in over-all dimensions), tapering to about 7 in. each way at the top. The stem and flange of the "T" are $3\frac{7}{8}$ in. thick throughout the full height of the post, and are reinforced (near the three extremities of the "T") with $\frac{1}{4}$ -in. round bars.

The concrete mixture is quite rich—about $1:1\frac{1}{2}:2$ of cement, sand and small-size coarse aggregate—the maximum size of the coarse material being about $\frac{3}{8}$ in.

The post, exclusive of the removable map slab, contains approximately $3\frac{3}{4}$ cu. ft. of concrete, so that its weight, with vibrated concrete weighing 150 lb. per cu. ft., is not far from 560 lb., a weight that may readily be handled with light equipment. By using light-weight concrete the weight, of course, could be considerably reduced.

It is suggested that this same principle could be applied with advantage to highway marking in the United States. Particularly on back roads would such sign posts at cross-roads be extremely useful to the motorist, for they would show where each road leaving the intersection leads. The post is manufactured by Crespi Brothers, Montevideo, Uruguay.

EDITORIAL

No Diversion Laws Repealed

Thus far no progress has been made toward the repeal or correction of state laws that divert gasoline taxes and motor license fees, notwithstanding the fact that forty-four state legislatures are (or were) in session since early January.

As a matter of fact, the state legislative trend is in the opposite direction. In Nebraska a new law has added a tax of one cent a gallon as a relief measure. In New York and Pennsylvania somewhat similar laws are pending. Nowhere has any definite action been taken toward returning diverted funds to their proper channels.

It is evident that heroic efforts will be required if anything constructive is to be accomplished during the present legislative sessions.

New Feature for the Products Industry

No one who attended the annual gatherings of manufacturers of concrete products during recent months could fail to sense the revived spirit prevailing in the industry. At the separate annual conventions of the National Cinder Concrete Products Association and the National Concrete Masonry Association, both held in New York; at the annual meeting of the Wisconsin Concrete Products Association in Milwaukee; at the conclave of the American Concrete Pipe Association in Chicago—everywhere this new vitality was evident.

Some manufacturers reported good business in 1934, though in all such cases the increased business was obtained only by going out after it.

Progressive manufacturers everywhere agreed that the NRA code of fair competition had been a benefit to the industry in sections where its provisions were observed, and a detriment in sections where it was allowed to be violated. This brings us face to face with the undeniable fact that the industry can be benefited only to the extent that the code is enforced against the price cutter and the quality chiseler.

For the purpose of simplifying code enforcement, the executive committee of the code authority of the Concrete Masonry Industry has wisely decided to decentralize code administration, placing responsibility into the hands of local groups who will serve in the double capacity of administrative agency and trade practice complaints committee within the local area. The national code authority will confine its activities to matters of broad policy and to the supervision of the local groups.

"Concrete" believes that code enforcement will be definitely simplified if the members of the industry

are kept informed as to their privileges and responsibilities under the code. In support of this belief, "Concrete" places its pages at the disposal of this industry, in the form of a new section under the heading of "The Concrete Products Manufacturer."

In this new feature section the members of the industry will find the Monthly News Letter of the secretary of the Code Authority of the Concrete Masonry Industry—a letter that will bring official information for the guidance of the industry, direct from the central authority.

Code news from other branches of the concrete products industry will be equally welcome.

Specialties in Concrete Products

During recent months "Concrete" has received an unusual number of inquiries from manufacturers of concrete products on the subject of specialties in this field. What special products have been found successful, and what marketing methods were employed?

This subject of specialties is always interesting, and it is easy enough to understand why manufacturers of concrete building block and tile are eager to branch out into something that will not be so dependent on an active building construction market.

Getting down to the actual selection of one or more special products is not so easy, for such a decision must be based on a careful market analysis and a considerable amount of guess-work.

It is true that the building industry itself offers one of the most promising concrete specialties—the precast reinforced concrete floor joist. This is one of the few concrete building products that can not also be produced in clay. Many products manufacturers have been successful in the manufacture and marketing of this unusual unit, which is destined to play an important part in building construction.

The story of a concrete specialty of a wholly different type comes from New Jersey, where a products manufacturer who makes colored concrete flower pots on a quantity-production basis and markets them at wholesale is working two shifts to keep up with his orders. From the southwest a products manufacturer located near several large towns and cities reports a fairly active demand for precast concrete curbs and posts for cemetery lots.

But there must be many others who have succeeded in finding or building up a local demand for some new and unusual concrete product. Manufacturers who have stories of this character to tell will do their fellow-manufacturers a definite favor by writing us about the making and marketing of these special products. Let us print the story, for the benefit of the entire industry.

PROGRESS — In a Page

◀ Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups. ▶

Cement Committee Is Active

Committee C-1 on Cement, of the American Society for Testing Materials, held a well-attended meeting in New York in February. Practically all of the subcommittees presented progress reports of the work in their jurisdiction. The extensive series of comparative strength tests under the sponsorship of the subgroup on high-early-strength cements was described. Several laboratories are now testing a large number of these cements and some of the current results were described.

Spirited discussion took place on the existing Tentative Specifications for High-Early-Strength Portland Cement (C 74-30 T) and as a result the committee is now conducting a letter ballot on the recommendation to adopt these as standard with one change, namely, the omission of all reference to fineness.

Questions which have arisen in connection with the Tentative Method of Test for Compressive Strength of Portland Cement Mortars (C 109-34 T) were reviewed and there was discussion of the work in progress on these involving rate of loading, normal consistency and the size graduation of the sands.

The working committee on volume change and soundness discussed the current work, in which there is now being tested in pastes and mortars the cements being studied by the high-early-strength committee, and also twenty commercial cements and thirty cements especially prepared in the P.C.A. Fellowship at the National Bureau of Standards. It is hoped that a progress report on this work will be ready by June.

British Concrete Pipe Standards

RECENTLY approved British Standard Specifications for Cement Concrete Cylindrical Pipes and Tubes (not Reinforced) provide for nominal sizes from 6 in. upwards and include requirements as to quality and hydraulic pressure, crushing and absorption tests.

Report Available on Concrete Tests

THE Report on Significance of Tests of Concrete and Concrete Aggregates prepared by Committee C-9 of the American Society for Testing Materials is now available, and members who have requested the copy to which they are entitled by virtue of their membership should receive it shortly. In view of the importance of this publication, which evaluates the various tests, it is thought that a number of the members may wish to procure additional copies. The special price to members is \$1, with reductions on orders for ten or more.

Effect of Calcium Chloride on Portland Cement

IN a paper presented by Paul Rapp before the December annual meeting of the Highway Research Board on "The Effect of Calcium Chloride on Portland Cements and Concretes," the author describes the results of tests conducted over a period of two years at the National Bureau of Standards at Washington. Cements of widely varying composition were employed in the tests. The tests included studies of heat of hydration, setting time, consistency, strength at various ages, and curing temperatures.

Calcium chloride increases the rate at which heat is evolved from all cements, and in general it gives an increase of about 4 calories per gram of cement at 24 hours. It decreased the time of set of eleven commercial cements and increased the flow of the concrete mix and the strength of the resulting concrete. The physical properties of all the cements were similarly affected by the addition of calcium chloride. Plastic mortar strength tests at three curing temperatures indicated that 1.3 to 2 per cent calcium chloride should be used integrally according to the rate of set of the concrete.

An extensive abstract of this paper is to be printed in a forthcoming issue of CONCRETE.

High Elastic Limit Steel

AT the recent annual meeting of the Highway Research Board, Profs. H. J. Gilkey and G. C. Ernst, of Iowa State College, presented a detailed discussion of the use of high elastic limit steel as concrete reinforcement. The paper is in the nature of a progress report.

Although from the standpoint of strength, it should be proper to use increased working stresses for high elastic limit steel, it is important to determine whether the added deflection, especially in the case of slender long-span flexural members, might not prove objectionable. Recent investigations of the effect of sustained static loads upon the deflections of reinforced concrete beams and frames indicate that factors of shrinkage, plastic flow and compressive reinforcement are important. The project is intended as a small but fundamental investigation to secure data upon the possible effect of increased working stresses in the steel under sustained flexural loading. Tables and curve sheets accompanying this report summarize in part the progress to date. A number of definite trends are indicated.

How Composition of Cement Affects Durability

H. S. MATTIMORE, in a paper read at the fourteenth annual meeting of the Highway Research Board, outlines a series of tests to determine the relation between the composition of cements and the durability of concrete and mortar. The tests are being undertaken by a number of co-operating laboratories.

The durability is to be measured by the effect of freezing and thawing on the specimens. Eleven types of cements are being studied, including those with high, medium and low amounts of tri-calcium silicate, tri-calcium aluminate, and tetra-calcium aluminoferrite. Progress has been made in analyzing the cements and calculating the compounds, and most of the laboratories have begun the freezing and thawing tests.

Architectural Concrete



ALFRED HOPKINS, *Architect*

Colored concrete coursed ashlar units in courses of four, six and eight inches produce this artistic effect in the Flinn Farm group of buildings recently completed at Banksville, Connecticut. The group is built around a quadrangle. The exterior trim stone is cast stone. Floors are of reinforced concrete.

The architect is Alfred Hopkins of New York and the builder is Mitchell & Company, of New Haven, Connecticut

New Ready-Mixed Concrete Plant Finds Market in Small Contracts



WITH no less than four established plants producing and selling ready-mixed concrete in Milwaukee, a year ago, the average observer would have regarded the field as being overcrowded.

There was one firm in Milwaukee, however, that saw things in a different light when they made a study of the situation in the spring of 1934. This was the Tews Lime & Cement Co. Phil J. Bliffert, general manager of the company, who has been in close touch with the construction industry of Milwaukee for 30 years, saw that the existing ready-mixed concrete plants were overlooking their best market—that of the small contractor who wants anywhere from 3 to 50 cu. yd. of concrete at a time.

Small Contractors Favor Ready-Mixed Concrete

Events and trends of recent years led up to the study by Mr. Bliffert and his associates. To begin with, small contractors in Milwaukee were drifting more and more toward the use of ready-mixed concrete, by means of which the handling of a contract of small size is so greatly simplified. This meant that, one by one, contractors were dropping out of the market for portland cement. The Tews organization, with six material yards in various parts of the city, began to notice this trend and the consequent dropping away of their customers for cement.

But along with his growing inclination toward ready-mixed concrete, the small contractor—strange as it seems in these times—often found it a difficult matter to get delivery. While this assertion seems ridiculous when one considers the low volume of construction during the past three or four years, the fact remains that almost every small contractor, at one time or another, ran head-on into this difficulty.

Why the "Little Fellow" Had Trouble

This trouble was due mainly to the fact that the producers of ready-mixed concrete in Milwaukee centered their attention on the larger contracts—those requiring concrete in amounts running up into the hundreds or thousands of cubic yards. Then, when a producer obtained a large contract requiring, let us say, several thousand cubic yards of concrete, all the facilities of his plant were required to supply concrete as rapidly as the contractor for the big job demanded it. During the time when this large contract was being serviced, the ready-mixed concrete plant was, therefore, unable to serve its smaller customers. In consequence, the "little fellow" was confronted with the choice of either mixing his own concrete or getting it from some other ready-mixed plant with which he had no previous dealings and no established credit.

After having sized up the market situation in the field

Older Milwaukee Producers Overlook Their Best Market While Scrambling for Large Jobs—Plant Is Model of Sim- plicity and Economy

of small contracts, the Tews company officials took the next logical step by making a study of the producing and selling methods best adapted to that field.

Plant Is Model of Simplicity

The answer to these questions is found in the plant built by the Tews company at its principal yard, at 1136 East North Avenue, in Milwaukee. It was put into operation on June 18.

The plant, a general view of which is shown in the illustration, is a model of compactness and simplicity—one that represents a surprisingly small capital investment—but it is capable of delivering ready-mixed concrete at the rate of one 2½-yd. truck-load every 5 minutes, which means 30 cu. yd. an hour when in continuous operation.

Central Proportioning, Transit Mixing

The plant is the centrally-proportioning type, all concrete being mixed in transit. The hillside location of the



Ready-mixed concrete plant, with capacity of 30 cu. yd. an hour, was built at a surprisingly low cost

plant simplifies the receipt of sand, gravel, and cement, these materials being delivered by truck from an upper street level and dumped directly into the storage bins in the upper part of the structure.

The aggregate bins, four in number, each have a capacity of 25 cu. yd., or a total of 100 cu. yd. The four bins are obtained by dividing the principal bin shown at the top of the structure into four compartments. Coarse aggregates are gravel, this material being kept on hand in two sizes, one with a maximum particle size of 1½ in. and the other having a maximum size of ½ in. Two kinds of sand—torpedo and masons' sand—occupy the remaining two bins. The cement storage bin adjoins the

aggregate bins, at the same level, hugging the larger bins closely, as the illustration shows. Deliveries of cement are also made by truck at the upper street level. The capacity of the cement bin is 270 sacks.

Since the picture here shown was taken, the part of the plant below the bins and above the weighing floor has been completely inclosed.

Plant Operations

All proportioning, including aggregates, cement and water, is made by exact weight. The aggregates are dropped from the storage bins into a weigh-batcher and from there to the mixing drum of the transit mixer. Cement is weighed on a separate scale, and is likewise dropped into the transit mixer. Water is also weighed by means of a special device, and is discharged through a 3-in. pipe into the mixing drum of the truck. In this respect this plant is unique, for no water is added in transit. With all materials, including water, introduced at the plant, the mixing drum is kept revolving during the entire trip from the proportioning plant to the construction job. No dependence need be placed on the driver of the truck.

The transit mixers approach and leave the plant in a straight line, without backing, each receiving its charge as it is dropped by gravity from the weighing boxes. When the plant started operations last June, three transit mixers were put into this service; but in a very short time it was found necessary to add two more. It is expected that additional transit mixers will be needed as soon as the 1935 construction season gets under way.

The intention is, also, to add a boiler room to supply heated mixing water, and steam for heating aggregates, during cold weather. During fall and spring months only the mixing water will be heated.

Extra Price for Better Service

In working out their sales plans, officials of the Tews company adhered to their purpose of serving the small contractor. Up to the present time the company has made no effort to obtain large contracts, for the simple reason that the competition for those contracts invariably results in ruinous prices, on which the ready-mixed concrete plant can not possibly realize a profit. By serving the contractors high-quality concrete and giving them prompt delivery, the Tews organization is able to sell its concrete at a profitable price.

How Quality Is Controlled

Prompt delivery is by no means the only service feature that appeals to the customers of this plant. Before delivery is started on a contract, an engineer from the Tews organization visits the job and sees that everything is in readiness and that the proper grade of concrete has been ordered. Careful control is maintained over the quality of the plant output, so that successive mixtures are uniformly workable and of uniform strength. At various times, during the day, the aggregates are tested for moisture content in order that corrections may be made in the quantity of mixing water. The yield, likewise, is tested at intervals of a few weeks or a month, by actually dumping charges of concrete into a measured box. The purpose in this is to avoid giving either an excess or a deficiency in volume.

The question of proportions has been handled in a most understanding way. The small contractor continues to think of concrete proportions as 1:2:3 or 1:2:4, and so on, though the concrete technologist knows that in the scientific control of quality such proportions can not be considered. But why argue the point? Instead, the engineers of the Tews organization have devised tables based on analyses of their aggregates, from which they can obtain the scientific proportions corresponding most closely to the various arbitrary proportions ordered by the contractors. Thus the contractor obtains the equivalent of what he has ordered, though it is, in fact, a scientifically proportioned mixture supplied on a guaranteed strength basis.

Acknowledgments

Walter F. Tews is in charge of the ready-mixed concrete division of the Tews Lime & Cement Co. Mr. Tews, himself an experienced concrete technologist, has the further advantage of experience in selling, and in the conduct of this division of the business he has succeeded in combining these two important factors.

The transit mixers employed at this plant are of two different types—several of them are of Rex manufacture (supplied by the Chain Belt Co. of Milwaukee), while the others are the Jaeger type (made by the Jaeger Machine Co., of Columbus). The Butler Bin Co., of Waukesha, Wis., designed and supplied the plant, including the steel bins for aggregates and cement, the supporting steel frame work, the proportioning scales—and, in fact, the complete structure.

Coming Conventions

March 3-10—Leipzig Trade Fair, Inc. Spring Trade Fair with Exhibits. Leipzig, Germany. Leipzig Trade Fair, Inc., 10 E. 40th St., New York City.

March 4-8—American Society for Testing Materials. Group Meetings. R. E. Hess, Asst. Secy., 260 South Broad Street, Philadelphia, Pa.

March 5-8—Southwest Road Show and School. 8th Annual. Wichita, Kansas.

March 6—American Society for Testing Materials. Regional Meeting, Philadelphia. R. E. Hess, Asst. Secy., 260 South Broad Street, Philadelphia, Pa.

March 12-14—American Railway Engineering Association. Annual. Chicago. E. H. Fritch, Secy., 59 E. Van Buren St., Chicago.

March 15-May 15—Chicago Better Homes Exhibit. Straus Building, Chicago. Howard J. White, General Chairman, 111 W. Washington Street, Chicago, Ill.

March 21-22—Wisconsin Concrete Products Association, Inc., 13th Annual. Pfister Hotel, Milwaukee. L. E. Schwalbe, Secy., 6332 W. State St., Wauwatosa, Wisconsin.

April 23-24—National Concrete Burial Vault Association. Annual. Statler Hotel, Cleveland, Ohio. J. H. Stuart, Secy.-Treas., Bremen, Ohio.

May 4-12—San Francisco Builders Exchange. Annual Building Exposition and convention. Civic Auditorium. Frederick Weddleton, 644 Mission Street, San Francisco, Calif., Manager.

May 6-10—American Water Works Association. Annual. Cincinnati, Ohio.

June 24-28—American Society for Testing Materials. 38th Annual Meeting and Exhibit of Testing Apparatus and Related Equipment. Book-Cadillac Hotel, Detroit, Michigan. R. E. Hess, Asst. Secy., 260 South Broad Street, Philadelphia, Pa.

Find Reinforced Concrete Highways Lowest in Maintenance Cost

New Jersey State Highway Department Keeps Detailed Records —Excellent Performance of Concrete Under Heavy Volume of Traffic

SINCE 1921 the New Jersey State Highway Department has kept complete records of the cost of maintenance of the highways within its jurisdiction. The records divide the maintenance into eight items, as follows:

A. Ordinary Maintenance. This includes (1) work on surface-traveled width; (2) work on paved shoulders; (3) work on unpaved shoulders, drains and ditches; and (4) work on guard rails and fences.

B. Extraordinary Repairs. This work includes (5) resurfacing, rebuilding,

heavy patching of main pavement; (6) rebuilding paved shoulders; (7) rebuilding unpaved shoulders and drains, new ditching; and (8) replacing guard rails and fences.

The maintenance cost of each of these items includes the cost of all labor and material, a proportional part of the cost of all equipment and tools, and a proportional part of the salaries and office expenses of the maintenance department. They do not include the cost of cleaning, snow removal, lighting, bridge maintenance and operation, and other similar items. These latter costs are kept separately and are not here included.

The greater part of the New Jersey state highways are paved with reinforced concrete, and there are sufficient

records to present maintenance costs of such pavements. Other types of pavement in the state are considerably more limited, and the records for them show the trend rather than the true average costs of maintenance.

The average annual cost of maintenance of unimproved shoulders, ditches and drains has been fairly uniform from year to year, and has amounted to \$8.00 per 100 sq. yd. of shoulder. The average annual cost of maintenance of guard rail has increased rather uniformly with the age of the guard rail. The average annual cost has been \$1.19 per 100 lin. ft. for rail built in 1931 and \$6.61 per 100 lin. ft. for rail built in 1921.

The individual portions of pavements shown in Table 2 are divided into two groups, those with average maintenance cost less than \$2.00 per 100 sq. yd. and those over \$2.00. This grouping is shown in Table 3.

Table 4 shows the average annual cost of maintaining reinforced concrete pavements, classified according to the age of the pavement. Groups 1 and 2 are those indicated in Table 3.

Type of Pavement	Length, Miles	Area, Sq. Yd.	Vehicles Per Day, Average	Cost
Reinforced concrete	736.1	10,548,300	4,700	\$ 0.70
Sheet asphalt, concrete base	25.8	459,000	4,600	1.34
Bituminous concrete, concrete base	75.1	1,273,800	7,000	2.13
Plain concrete (prior to 1923)	122.8	1,438,600	2,800	2.55
Sheet asphalt, macadam base	37.9	459,600	2,900	3.86
Bituminous penetration macadam	12.6	218,700	2,700	5.53
Gravel	57.1	536,100	1,000	6.49
Bituminous concrete, macadam base	67.9	894,300	6,400	8.34
Macadam	14.8	170,600	3,000	13.28

Maintenance Started in Year	Length, Miles	Area, Sq. Yd.	Vehicles Per Day, Average	Cost
1923	30.7	383,780	2,400	\$1.29
1924	76.9	1,124,580	3,800	0.56
1925	93.6	1,231,290	3,400	0.57
1926	67.3	870,330	3,500	0.81
1927	15.9	244,260	7,800	0.48
1928	121.4	1,620,830	3,600	0.43
1929	104.7	1,572,960	4,500	0.84
1930	118.1	1,827,110	7,000	0.86
1931	107.5	1,673,130	5,800	0.70

Maintenance Started in Year	Group 1		Group 2		Total Cost
	Percentage	Cost	Percentage	Cost	
1923	67	\$0.70	33	\$2.46	\$1.29
1924	95	0.45	5	2.81	0.56
1925	98	0.54	2	2.46	0.57
1926	94	0.70	6	2.98	0.81
1927	100	0.48	0	—	0.48
1928	100	0.43	0	—	0.43
1929	85	0.55	15	2.48	0.84
1930	83	0.52	17	2.52	0.86
1931	90	0.34	10	4.00	0.72
Average	91	0.50	9	2.72	0.70

TABLE 4—AVERAGE ANNUAL COST OF MAINTENANCE OF REINFORCED CONCRETE PAVEMENT ACCORDING TO AGE

Year of Maintenance	Cost per 100 Sq. Yd.	
	Groups 1 and 2	Group 1
First	\$0.52	\$0.45
Second	0.60	0.42
Third	0.64	0.43
Fourth	0.84	0.61
Fifth	0.80	0.54
Sixth	0.72	0.67
Seventh	0.61	0.58
Eighth	0.62	0.52
Ninth	0.49	0.45
Tenth	1.14	0.47
Eleventh	4.21	0.47

The average annual cost of maintenance of concrete pavement appears to have varied with the volume of traffic about as shown in Table 5. As would be expected, the maintenance cost increases directly with the volume of traffic, though not in the same proportion.

Average Number of Vehicles per Day	Cost per 100 Sq. Yd.
800	\$0.40
1,600	0.50
2,400	0.54
4,000	0.71
6,400	0.74
9,600	0.92
22,000	2.15

The Concrete Products Manufacturer

Code Administration

+ + +

News of the Industry

ANNUAL meetings of manufacturers of concrete products, held in recent months, have given ample evidence of a new vitality in this branch of the concrete construction industry. Many individual manufacturers reported a distinct improvement in volume of business in 1934.

As to the codes of fair competition, the concrete masonry industry, in particular, has found it difficult to enforce its code, doubtless because of the great number of individual plants. Progressive manufacturers have found this code of definite benefit wherever its provisions have been observed, but a distinct detriment in regions where frequent violations have been permitted.

CONCRETE believes that compliance with the code constitutes the very life-blood of the concrete masonry industry. CONCRETE believes also that code enforcement will be simplified if manufacturers are kept informed of code matters affecting them. With these points in mind, this new feature section, *The Concrete Products Manufacturer*, places at the disposal of the concrete masonry industry the necessary space for the *Monthly News Letter* of the secretary of the Code Authority. This letter will appear in each issue of CONCRETE.—The Editor.

Monthly News Letter + Concrete Masonry Industry

By H. W. BUSH

Secretary-Treasurer, The Code Authority for the Concrete Masonry Industry
211 Edgemont Place, Teaneck, N. J.

"The question of passing news to the members of the industry," writes the secretary of the code authority for the Concrete Masonry Industry in a letter to the editor of CONCRETE, "has been one of vital concern to the Code Authority. We have not had the necessary funds to broadcast information to the members direct. I am therefore taking the liberty of asking CONCRETE to publish, each month, news regarding our code and its administration."

—Editor.

INSTANCES of unlawful price fixing by certain groups have come to the attention of the government and the code authority. It is probable that this was done without intent to violate the law. It must be remembered by the members of our industry that the Sherman Act (anti-trust laws) has not been suspended. The open price provisions contained in your code of fair competition, which require the publishing and filing of prices, are not price fixing. Complaints of unlawful price fixing are being investigated by the Department of Justice, and your code authority and members of the industry are cautioned to avoid any

acts which may be in violation of the anti-trust laws.

Code Authority Finances

The audit of the Treasurer's accounts for the calendar year 1934 has been submitted by a public accountant to the Administration at Washington. It shows that during this period the amount of \$8,045 has been collected from the members of the industry in both voluntary and mandatory contributions. This amount was contributed by members of the industry in 38 states, the members of the industry in the state of New York having paid the greatest amount. The amount received has been expended principally as follows:

\$1,700 for salaries, practically all of this being for stenographic services.

\$4,400 for rent, telephone and telegraph, postage, stationery, printing, insurance, traveling expenses and miscellaneous expenses.

\$1,000 paid to members of the code authority in connection with expenses in attendance at meetings.

\$900 paid to representatives of the code authority for expenses in connection with the administration of the code.

The total expenses for the period were \$17,700, leaving a deficit of \$9,600.

At the meeting of the code authority, held in New York City on February 16, at which all the members were present and representatives of the United States Government as well, it was determined that action be taken immediately to compel all members of the industry to pay the approved assessment for 1934. Obviously, it is not fair for one member of the industry to pay the assessment and for his competitor to pay nothing. In connection with the balance due on 1934 assessments, the following resolution was passed:

RESOLVED, that the Secretary be instructed to notify authorized representatives of Code Authority that they may be paid an amount up to 25 per cent of the assessments collected in their territories for expenses in collection of the balance of the 1934 budget; and it was further

RESOLVED, that the amount so paid out to authorized representatives of Code Authority should not exceed the amount for that particular item as set forth in the budget. Bills for the payment of expenses of local administration must be supported by vouchers and approved in the usual manner.

Decentralization of Code Activities

The sad story of the effects of the depression on members of this industry is known by heart to all of our friends. We believe the depression is over. Business is raring to go. Getting a start is largely a question of confidence and fair dealing. Every member of the industry knows that the future of our industry depends on adhering to the principles of fair dealing. You have declared yourselves in favor of fair open competition in op-

position to secret destructive methods. Your code authority believes that the only way in which to administer your code effectively, so that you may derive the benefits to which you are entitled, is by local group administration. The following procedure is, therefore, recommended to all groups of the industry, whether large or small:

An immediate election of at least three members of the industry from the local group, who will act as the administrative agency of the code and as a trade practice complaints committee. In the election of committees, consideration must be given to the two divisions of the industry, namely, the Cinder Unit Division and the Concrete Masonry Unit Division in Section 13 (a), Article VI. (Read Section 12 (a) of Article VI). After the election of the group committee, the following procedure is necessary:

1. *Letter of Transmittal*, addressed to the secretary of the code authority. This letter must include the following points, or they must be covered by separate documents:
 - a. Request for official recognition of the group.
 - b. Statement that the election was fair and in accordance with the provisions of the code.
 - c. Outline of the election including:
 - (1) Notice of election, whether by publication and/or individual notices by mail to all known members of the industry in the territory.

- (2) Details of the nomination.
- (3) Method of voting (whether by mail or in person at meeting, and if the latter, whether voting by proxy was permitted).
- (4) Basis of voting (by units, by areas, or combination of units, with volume factors, such as production, sales, number of employees, etc.).

- d. Statement that all available sources of information were utilized in preparing the list of members of the industry for participation in the election.
- e. List of committee members, including the following information:
 - (1) Address.
 - (2) Chairman, secretary, etc.
 - (3) Present business affiliations.
 - (4) Period for which elected.
- f. Mention of all accompanying documents.
2. *List of all known members* of the industry in the territory to whom notices were sent.
3. *Tabulation of the election*, including:
 - a. Total number in industry.
 - b. Potential number of votes.
 - c. Total votes cast.
 - d. List of candidates, including:
 - (1) By whom named.
 - (2) Number of votes received.
4. *Sample copies of all notices* of election, ballots, etc., used in conducting the election.
5. *Copies of, or extracts from, the minutes*, duly certified by an authorized party of the meeting of the code committee or other body conducting the

election which are pertinent to the election.

6. *Constitution and by-laws* of any trade association or associations participating in the election, if any.
7. *Any other documents or evidence* tending to establish the fact that the election was fair and in accordance with all pertinent provisions of the code.

Budgets should immediately be prepared by local groups, listing in detail the various items and the basis of assessment. These assessments, when approved by the code authority and the administration, will become binding on each member of the industry in that group.

It has been felt by the executive committee and the majority of members of the code authority that only a small portion of assessments should be paid to the national code authority. With that in mind, the executive committee has recommended the immediate revision of the 1935 budget so that the assessments paid by each member of the industry to the national code authority will be \$6.00 per year, payable in one lump sum or semi-annually. All other moneys will be collected by various groups in accordance with their budget and used in their entirety for the administration of the code in their territories.

Code Authorities

FOLLOWING are the addresses of the code authorities of industries and branches of industries related or of interest to the concrete construction industry. When writing to a code authority, include the words "code authority" in the address, thus: Code Authority, Construction Industry, National Press Building, Washington, D. C.

Builders' Supplies Trade, Room 1907—Investment Bldg., Pittsburgh, Penna.

Cement-Gun Contractors Industry, 651 Munsey Bldg., Washington, D. C.

Concrete Burial Vault Industry (Chairman of Code Committee is L. A. Chick, care of Blairsville Concrete Products Co., 100 North East Lane, Blairsville, Penna.)

Concrete Masonry Industry, 211 Edgemont Place, Teaneck, N. J.

Concrete Mixer Manufacturing Industry, 221 W. Madison St., Chicago, Ill.

Concrete Pipe Industry, 33 W. Grand Ave., Chicago, Ill.

Construction Industry, National Press Bldg., Washington, D. C.

Construction Machinery Distributors Trade, 207 W. Pearl St., New York, N. Y.

Crushed Stone, Sand and Gravel, and

Slag Industry, Munsey Bldg., Washington, D. C.

General Contractors' Industry, 222 Munsey Bldg., Washington, D. C.

Portland Cement Industry, 111 W. Washington St., Chicago, Ill.

Ready-Mixed Concrete Industry, 951 Munsey Bldg., Washington, D. C.

Reinforcing Materials Fabricating Industry, 201 North Wells St., Chicago, Ill.

Steel Joist Industry, 201 N. Wells St., Chicago, Ill.

Waterproofing, Dampproofing, Caulking Compounds and Concrete Floor Treatments Industry, 11 West 42nd St., New York, N. Y.

Interpretations

CONSTRUCTION INDUSTRY

No. 244-49

Facts.—A State agency prescribes that any member of the construction industry doing certain work for the State shall pay the "prevailing wage" in the "locality" in which the particular project is being performed.

Question.—Is this a sufficient action to permit a contractor having a contract with the State to obtain the exemption provided in section 3 of ar-

ticle III of chapter I, of the Code of fair competition for the construction industry which reads as follows:

"Where provisions concerning hours of labor or rates of pay have been established for specific projects, by competent governmental authority or agencies (whether Federal, State, or political subdivisions thereof) acting in accordance with law, any employer required to comply and complying with the provisions so established shall be relieved of compliance with any conflicting provisions of this article."

Interpretation.—A provision concerning hours of labor or rates of pay within the meaning of the above quoted section 3 is required to be specific and definite. The action of the State agency is defective, not only because "prevailing wages" are not susceptible of a specific and definite determination, but also because of the requirement that the prevailing wages be those in the "locality" in which the particular project is being performed. It cannot be said with any degree of accuracy what areas constitute the locality in which the particular project is to be performed.

Insulating Value of Residence Walls

Heat Loss Through Walls Has Little Effect on Fuel Bills—
Major Losses Through Windows, Doors and Roof

By W. G. KAISER

Manager, Cement Products Bureau, Portland Cement Association, Chicago, Ill.

THE ideal house-building materials are those that provide the optimum combination of structural stability and durability, fire-proofness, watertightness and heat insulation at a reasonable cost. The insulation value of the different types of materials used in building walls varies with the characteristics of the materials. Tests have been conducted to determine the loss of heat occurring through these walls.

Comparing Insulating Values

Table 1 shows the heat loss of some of the commonly used combinations of materials for exterior walls in residence construction. The values have been taken from Tables 8, 9 and 10 of the 1934 Edition of the *Heating and Ventilating Engineers' Guide*, the standard reference in the United States. The heat loss is expressed in British thermal units¹ (B.t.u.), in loss per hour per square foot per degree Fahrenheit, and in difference in temperature between air on two sides, and is based on a wind velocity of 15 miles per hour.

A study of this table shows that the heat loss varies over a fairly wide range. The best combination of materials cited, face brick exterior with 8-in. cinder concrete block back-up, 1/2 in. of plaster on 1 in. of rigid insulation, furred, costing \$810 per thousand square feet, is three times as effective in preventing heat loss as the bare cinder block wall costing \$260 per thousand square feet.

Where Heat Losses Occur

If all the heat losses in the house occurred through the walls, it would be a comparatively simple matter to select the most efficient wall and justify the additional expenditure in the saving of fuel bills, minus the inter-

est on the additional investment required. In this case, 6 per cent of the additional investment is \$33 per year.

Unfortunately, the problem is not so simple. The 27 by 34-ft. uninsulated 1 1/2-story house built with standard wood frame construction with 25 per cent of the wall area in windows and doors will have the following heat loss through the various structural parts:

35 per cent through windows and doors.

30 per cent through roofs and floors.
20 per cent through the walls.
15 per cent through cracks and crevices around wall.

Under average conditions, the actual annual fuel bill for such a house will be \$100. If all the heat loss through the walls were eliminated, the maximum possible saving in fuel bill would be near \$20, other conditions remaining the same. The elimination of all heat lost through the walls is not practicable. It has been suggested by some authorities that a practicable minimum heat loss through the walls is 0.10 B.t.u.

Spending Too Much for Insulation

To reduce the heat loss to this point, with practically any type of exterior wall construction, the addition of 2 in. of cork (or its equivalent) to the structural walls would be required. This amount of insulation added to the

TABLE 1—COEFFICIENT OF TRANSMISSION "U" OF RESIDENCE WALLS

		Interior Finish 1/2-in. Plaster on—				
Wall construction	None	Wall alone	Wood lath, furred	Metal lath, furred	1-in. rigid insulation, furred	2-in. cork
Solid brick, 8 in.	0.50	0.46	0.30	0.32	0.16	0.11
Hollow cinder block, 8 in.	.42	.39	.27	.28	.16	.11
Hollow stuccoed exterior, 9 in.	.40	.38	.26	.27	.16	.11
Hollow concrete block, 8 in.	.56	.52	.32	.34	.17	.12
Monolithic concrete, 6 in.	.79	.70	.39	.42	.19	.12
Wood siding on wood sheathing on 2-by-4 studs	—	—	.25*	.26	.15	.095
Brick veneer walls, 4 in.	—	—	—	—	—	—
Cinder block, 8 in.	.35	.33	.24	.25	.14	.10
Concrete block, 8 in.	.44	.42	.28	.30	.16	.11
1-in. wood sheathing, 2-by-4 studs	—	—	.27	.28	.15	.098

*Standard wood frame construction.

TABLE 2—COST OF FUEL FOR STANDARD HOUSE WITH DIFFERENT TYPES OF WALLS

		Interior Finish 1/2-in. Plaster on—				
Wall construction	None	Wall alone	Wood lath, furred	Metal lath, furred	1-in. rigid insulation, furred	2-in. cork
Solid brick	\$120.00	\$116.80	\$104.00	\$105.60	\$92.80	\$88.80
Cinder block	113.60	111.20	101.60	102.40	92.80	88.80
Stuccoed	112.00	110.40	100.80	101.60	92.80	88.80
Concrete block	125.00	121.60	105.60	107.20	93.60	89.60
Monolithic concrete, 6 in.	143.00	136.00	111.20	113.60	95.20	89.60
Standard wood frame	—	—	100.00	100.80	92.00	87.60
Brick veneer walls	—	—	—	—	—	—
Cinder block back-up	108.00	106.40	99.20	100.00	91.20	88.00
Concrete block back-up	115.20	113.60	102.40	104.00	92.80	88.80
Wood frame	—	—	101.60	102.40	92.00	87.85

TABLE 3—COST OF WALLS PER 1,000 Sq. Ft.

		Interior Finish 1/2-in. Plaster on—				
Wall construction	None	Wall alone	Wood lath, furred	Metal lath, furred	1-in. rigid insulation, furred	2-in. cork
Cinder block	\$270.00	\$348.00	\$460.00	\$460.00	\$540.00	\$550.00
Standard wood frame	—	—	460.00	460.00	540.00	550.00
Adjusted fuel cost, cinder block construction	101.20	104.40	101.60	102.40	97.60	93.60

¹ Quantity of heat required to raise the temperature of 1 lb. of water 1 deg. F.
Presented at annual convention of National Concrete Masonry Association, New York City, Feb. 19, 1935.

walls in the above house would reduce the actual annual fuel bill only \$12.

$$\text{Fuel saving} = \frac{\text{"U" before insulating} - \text{"U" after insulating}}{\text{"U" before insulating}} \times \text{cost of heating walls.}$$

In this instance, the fuel saving is—

$$\text{Fuel saving} = \frac{0.25 - 0.10}{0.25} \times \$20 = \$12$$

The cost of heating this standard house with each of the different types

of walls shown in Table 1, all other conditions remaining the same, has been calculated in the above manner

and is shown in Table 2. These values are based on the assumption that the actual fuel bill for the uninsulated house is \$100.

Study of this table discloses that the different types of wall construction

exert but a minor influence on the cost of heating a home. The difference in cost between the various types of construction without additional insulation is not enough to justify the use of non-fireproof construction on the basis of heat insulation alone. Additional insulation built into the walls results in only very small differences in the cost of heating the home. The cost of the additional insulation is practically the same, irrespective of the type of wall to which it is applied.

Demand for Special Cements in Construction Work

P. H. Bates, in Concrete Institute Paper, Explains Growing Need for Several Types of Cement to Meet Differing Construction Requirements

THERE is a marked trend in this country away from the use of one standard type of cement for all construction projects, according to P. H. Bates, chief, clay and silicate products division, National Bureau of Standards, Department of Commerce.

In a paper entitled "Trends in the Production and Use of Various Types of Hydraulic Cements," presented by Mr. Bates at the meeting of the American Concrete Institute in New York City (February 19), he pointed out that consumers, in particular, are demanding more types and more varieties within any one type of cement to meet the requirements of special construction projects.

There is the standard portland cement used in the majority of cases, as covered by the present Federal and American Society for Testing Materials specifications; low-heat-of-hardening cements, such as are being used for Boulder Dam; portland cement to resist sea water and other waters containing destructive salts; and the high-early-strength portland cements used to some extent by almost every state highway department and many municipalities.

The increasing use of these cements will, according to Mr. Bates, result in better concrete. The project on which the cement is to be used must be carefully studied to determine whether a

saving will result from the employment of a special cement which will cost more than standard portland cement, but which may speed up construction or make possible a lighter structure.

Thus, he stated, a large concrete bridge has recently been completed in France in which a high-early-hardening cement was used because the designer found from tests that by so doing he could use lighter sections than if he had employed the cheaper but lower-testing portland cement. This resulted in the higher priced cement yielding the lower costing bridge.

Many of these special cements have a background of long use in Europe, and even in the United States they have been used off and on for many years, but this does not seem to be generally understood, according to Mr. Bates.

He pointed out that it is not to be supposed that all producers will make all the varieties of cement which seem likely to be in demand.

"If any manufacturer can continue to make standard portland cement and dispose of it at a rate and a price that will yield him adequate continued returns on his investment, he should bend his efforts to continue in that advantageous position," he said.

"But, if he is assured that the continued demand for another type of

cement or a different grade of portland cement will justify his making it, and in so doing he can obtain a satisfactory return on the needed additional investment to produce it, he would be foolish not to take advantage of the opportunity.

"Likewise, it is not to be supposed that the use of special cements will result in 100 per cent success in all cases. Not even nature can make any great masses of perfect rock. All our deposits of building stones yield a quota of material that can not be used for structural purposes.

"It must be remembered also that special cements require special handling. Cements having decided advantages along some lines are not so good in other respects. For instance, designers who are inclined to use not only the high-alumina cements but also the very rapidly hardening portland cements should beware of large masses of concrete unless they use artificial means of cooling.

"The various types of hydraulic cements are here, and here to stay, and there is no use 'kicking against the pricks.' Accept the new cements as gracefully as possible, make them if money is to be made in producing them; but if not, don't assume any obstructive attitude. Remember, the world moves on and you either keep pace or you are lost."

Just Out . . . New

BRANFORD VIBRATOR SPADE

Compressed Air Operated

For Walls, Columns, Caissons, Etc.

This new Branford vibrator spade operates in a horizontal position—requires no spring for starting and operates at as low a pressure as 20 lbs. to 30 lbs. depending upon the slump.

The vibrator blades are spaced that 3" aggregate is easily cleared by the three spade blades that are a part of a removable housing bolted through on to the vibrator unit. The housing is renewable when worn and a new set easily bolted (four bolts) to the vibrator unit which is an integral unit complete in itself, the housing being merely a wearing piece.

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TYPE 1455-B. No. 1 size (shown at left) has a supplementary blade 24" long and 4" wide, corrugated, and is used as an attachment to the standard type 1455-A to produce a smooth, voidless surface, eliminating patching and finishing.

TYPE 1455-A. No. 1 size (shown at right) blades are 12" long and 4" wide. This spade is especially designed for use between reinforcing and the inside face of the form.

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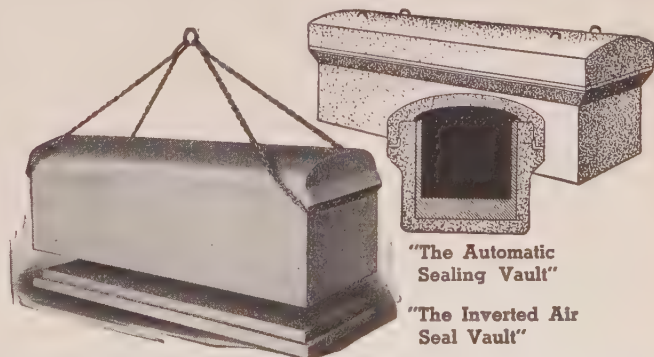
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Wisconsin Products Men Discuss Variety of Subjects

THE Federal housing program, the place of concrete products in PWA construction, concrete masonry in architecture, the painting of concrete, colored concrete, the progress of concrete masonry in 1934, the use of concrete masonry in school building and theatre construction—these were

Kaiser Talks About Ashlar

Moving pictures and still-picture films illustrated other features of interest. Notable among these was the illustrated talk by Wm. G. Kaiser, manager of the cement products bureau of the Portland Cement Association, in which he demonstrated the

techniques who specialize in this type of work is constantly growing. In all cases they have been able to produce highly artistic effects at a surprisingly low cost, and because of this fact their services have been in demand.

Officers for Coming Year

New officers for the coming year include Edward Olsen, of the Badger Concrete Co., Oshkosh, as president. The first vice-president is Walter Manhardt, of the Best Block Co., Milwaukee; the second vice-president is Ira Westerveld, of the Wausau Concrete Co., Wausau; and the secretary-treasurer (re-elected) is L. E. Schwalbe, of the Economy Concrete Products Co., of Wauwatosa.

The board of directors consists of six regional representatives and three directors-at-large. The regional directors, named in order from the first to the sixth region, include L. E. Schwalbe, of Wauwatosa; Arthur Sorenson, of Racine; Charles Clare, of Madison; Edward Olsen, of Oshkosh; A. Kruschke, of Eau Claire; and Ira Westerveld, of Wausau. The three new directors-at-large are Arthur W. Devos (retiring president), of Milwaukee; Arthur Grube, of Sheboygan; and Walter Manhardt, of Milwaukee.

Concrete products manufacturers from several surrounding states were present, and the annual banquet was attended by 135 delegates and visitors.



At right, interior of Virginia Theatre, Detroit, remodeled with an interior of cinder concrete ashlar veneer. The remodeled exterior is a new unit known as Macotta, made of enameled steel sheets with haydite concrete backing

some of the great variety of problems and subjects discussed at the thirteenth annual meeting of the Wisconsin Concrete Products Association, held at the Pfister Hotel, in Milwaukee, on March 21 and 22.

striking architectural effects of concrete ashlar masonry. His illustrations included views of recent work in both coursed and random ashlar masonry, in exterior construction and in interior wall finishes. The list of archi-

First House Concrete!

(Continued from page 17)

New York, and John Donald Tuttle, of New York.

Plans Indicate Home of Future

The home of the future, as indicated by these plans, will be of the flat roof, modern type, somewhat as displayed at the Century of Progress in Chicago.

Fully 75 per cent of the plans not only depicted this type, but offered other radical changes in home construction. The tendency is for the garage to be placed at the front of the house with the kitchen adjoining, and the living room across the rear, facing the yard and garden. All plans gave

particular attention to the layout of the yard with its shrubbery and flowers. Although all plans permitted any type of construction, the tendency as shown by the flat roof type of home would be to build it of *concrete, stucco or brick*—and from other sources it is learned that the first of the prize houses to be built will be of concrete!

Greater utilization of the cellar or basement, now commonly used for the furnace and the laundry, was also brought out in the many designs. The new tendency is to use this space for a recreation or play room for children.

Drawings show that time-saving, step-saving, and labor-saving had been the rule in the studies of the architects. The plans indicate that the majority

of competitors sensed that this was to be a competition in which emphasis would be laid upon planning, rather than on exterior design.

E. K. Smith Passes Away

Edward King Smith, Chicago, formerly assistant manager of the Chicago highways bureau of the Portland Cement Association, died March 8 at Beloit, Wisconsin.

Mr. Smith was a former vice commander of the Advertising Men's post of the American Legion. He was a captain of engineers in the 311th Combat Engineers, army reserve corps. Surviving are his widow, an infant daughter, and his mother.

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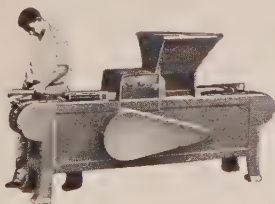
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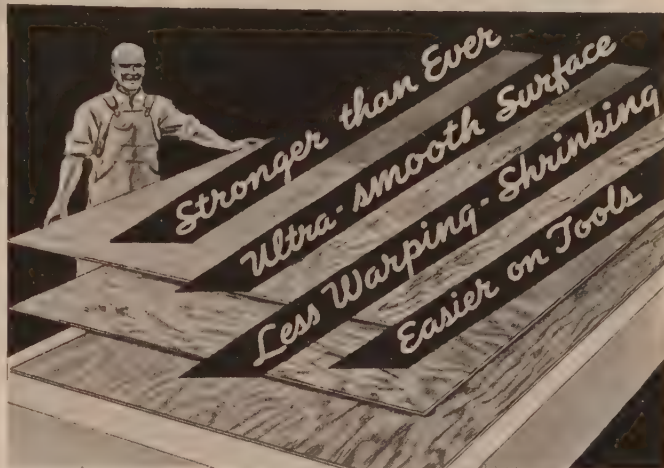


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Porous Concrete Drain Tile

Can you refer me to any reliable data on the manufacture of porous concrete drain tile?—L. N. J., Lyndhurst, N. J.

The manufacture of porous concrete drain tile has been brought to the commercial stage by at least one company. We are asking that company to send you its printed literature.

Monolithic Glazing

On page 22 of your January issue there is a reference to a "monolithic glazing" on concrete building units in wall construction. What is the character of this glazing?—D. C. I., Palm Beach, Fla.

The glazing mentioned in the particular case to which you refer is known as the "Colorcrete" process, developed by Colorcrete Industries, Holland, Mich.

Cement Grout Coatings on Steel Tanks

I am told that some time ago CONCRETE published an article on the use of portland cement grout on the inside of steel water tanks to prevent corrosion of the steel. Will you kindly let me have this reference?—W. S. S., Cincinnati, Ohio.

The article to which you refer appeared on page 20 of the March (1934) issue of CONCRETE.

Granite Chips

Can you refer me to companies that supply granite chips for producing a granite finish in cast stone for buildings, monuments, and related products?—V. H. T., Corpus Christi, Texas.

Some producers of natural granite building stones and monuments prepare the chips obtained as a by-product in their operations for use as special facing aggregates. It is suggested

that you get into touch with such companies in your section. Other companies produce special facing aggregates as their principal line. A list of these latter companies is being forwarded to you.

Coke Breeze Concrete Units

We would like to know where to obtain particulars of the correct materials and proportions to be used in the manufacture of coke breeze concrete blocks.—R. T. M., Dublin, Ireland.

While considerable experiments have been made with coke breeze in this country, and a few manufacturers have at different times made these blocks, not much interest has been aroused. No doubt this is due to the general prevalence of light-weight aggregates such as haydite, cinders, and specially processed slags. Some tests conducted by the Portland Cement Association and described in detail in the *Journal* of the American Concrete Institute of November, 1932, included tests of coke breeze block, the breeze consisting of coke screenings from the $\frac{3}{8}$ -in. size down to fine dust. This, however, was purely experimental.

The British Department of Scientific and Industrial Research has made a much more extensive investigation of coke breeze than has been accomplished in this country. We refer you in particular to Bulletin No. 5 of the building research publications published in 1928 under the title of "The Properties of Breeze and Clinker Aggregates and Methods of Testing their Soundness," by F. M. Lea. Copies can be obtained at 6 d per copy, from His Majesty's Stationery Office, Adastral House, Kingsway, London, W. C. 2, England.

Floor Hardeners

What are some of the chemicals that have given good service as concrete floor hardeners, and where may such chemicals be obtained?—A. R. K., Davenport, Iowa.

Among the chemicals most common-

ly used in the preparation of concrete floor hardeners are magnesium fluosilicate and zinc fluosilicate. These chemicals are dissolved in water and are applied to the floor by being flushed or brushed over the surface and allowed to penetrate the concrete.

First, however, it is necessary to give the concrete floor a thorough cleaning, to remove all traces of oil, grease, paint or other substances. Unless this is done the chemical solutions can not penetrate to a depth sufficient to enable them to react with the free lime in the concrete. The surface must also be thoroughly dry, to avoid diluting the chemical solution.

The hardener solution is spread over the floor in several applications. For the first application a weak solution is used, usually about half a pound of the fluosilicate to every gallon of water. This is spread over the floor and allowed to dry for 3 or 4 hours. Then the second application is put on, this being a stronger solution—about 2 pounds of the fluosilicate to every gallon of water. Any additional applications should have the same strength as the second, and in all cases some 3 or 4 hours must elapse between applications.

A gallon of the solution may be spread over a floor area of 100 to 150 sq. ft. After the last application has dried, the floor should be mopped to remove any precipitated salts, thereby preventing the formation of white stains.

As to the purchase of such chemicals, they may, of course, be obtained from any chemical supply house. However, unless the work you contemplate doing is in the nature of an experiment, we recommend that you obtain one of several good commercial floor hardeners available on the market. These you can obtain through material dealers. An inexperienced man attempting to mix his own floor hardeners is in a position somewhat similar to that of an amateur house painter who attempts to mix his own paints. In either case the commercially mixed product will bring better results.



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By A. E. WYNN

Contents

- Chapter I.—Form Building in General
- Chapter II.—Materials, Loads, Pressures and Stresses
- Chapter III.—Theoretical Design of Forms
- Chapter IV.—Design Tables
- Chapter V.—Design Problems
- Chapter VI.—Detail Construction of Footing Forms
- Chapter VII.—Detail Construction of Column Forms
- Chapter VIII.—Wall Forms
- Chapter IX.—Detail Construction of Beam and Girder Floor Forms
- Chapter X.—Forms for Rib Floors and Structural Steel Fireproofing
- Chapter XI.—Miscellaneous Forms in Building Construction
- Chapter XII.—Form for Flat Slab Construction
- Chapter XIII.—Forms for Conduits, Sewers and Culverts
- Chapter XIV.—Forms for Tanks, Silos, Bins and Standpipes
- Chapter XV.—Forms for Dams, Piers and Heavy Walls
- Chapter XVI.—Steel Forms in Building and Wall Construction
- Chapter XVII.—Steel Forms for Curved Surfaces
- Chapter XVIII.—Arch Falsework
- Chapter XIX.—Other Bridge Forms
- Chapter XX.—Patent Devices
- Chapter XXI.—Planning the Work

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From the Patent Office

By J. KAPLAN

Patent Attorney, Washington, D. C.

Colored concrete: George R. Tucker, North Andover, Mass. U. S. Pat. 1,972,207.—The process of preparing colored concrete consists of mixing water, a calcareous substance, and a finely divided coloring material in the presence of a soluble compound obtained by condensing formaldehyde with a sulfonic acid of the naphthalene series.

Colored concrete: George R. Tucker, North Andover, Mass. U. S. Pat. 1,972,208.—The process of preparing colored concrete consists of mixing water, a calcareous substance, and a finely divided coloring material in the presence of a soluble compound obtained by condensing formaldehyde with an aromatic sulfonic acid.

Artificial stone floor: E. J. Milburn, Chicago, Ill. U. S. Pat. 1,968,784.—The artificial stone floor comprises: the reaction of products obtained by the intimate mixture of 100 lbs. of calcined magnesite, enough sawdust to displace twice the space taken by the magnesite, enough fine stone screenings to displace half of the place taken by the magnesite, 100 lbs. of magnesium chloride, 1½ gallons of emulsified asphalt, and sufficient water to make a mixture of the consistency of soft mortar.

Reinforced concrete—floor, roof, wall and the like: Martyn Noel Ridley, Leeds, England. U. S. Pat. 1,971,658.—The structure comprises a girder-like assembly consisting of upper and lower chords united at their ends, each of the chords comprising a sheet corrugated lengthwise of the truss, and spacers intermediate. The ends of the sheets are to form webs, one sheet of the unit acting as a form for plaster material during the process of construction—unit constituting a permanent part of the completed structure.

Freeing clay from stone: H. Rafetto, Wayne, Pa. U. S. Pat. 1,966,312.—The method of separating pit clay or equivalent material in substantially unadulterated form from a mined aggregate containing stone of various and considerable size, consists in continuously feeding said aggregate in its natural state and substantially as removed from its natural bed into a rotary perforated drum, and rotating the drum whereby the clay in its natural state and substantially as removed from its natural bed is ground and screened and so separated from the stone and the stone is continuously evacuated from the drum.

Method of providing roadways with a nonskid surface: Edwin C. Wallace, Newton, Mass. U. S. Pat. 1,975,028.—The structure comprises a body layer with a coating of asphaltic paint adherent thereto, an intermediate layer of fine plastic mixture consisting essentially of fine mesh aggregate coated with bituminous cement, and a surface layer of medium-coarse bituminous mixture consisting principally of substantially uniform size stone larger than the mineral particles in the intermediate layer as well as a small proportion of fines all coated with bituminous cement. This provides a wearing surface of open granular texture with relatively large interstices between the stone of the surface layer, the intermediate layer of fine plastic mixture providing a holding medium in which the relatively coarse particles of the granular surface layer are but partially embedded.

Pavement and other surface construction: Lionel Robert H. I. Killara, New South Wales, Australia. U. S. Pat. 1,966,760.—The process of the construction of road pavements includes keyed sections having approximate parallel sides in which process natural earth material selected from a group consisting of shale, clay and their equivalents is first drained upon the site of the pavement, then shaped and watered while consolidated by rolling with suitable weight, pugged, puddled and trimmed to an even surface of the desired shape, said surface being then divided into substantially parallel sided and keyed sections of mutually corresponding shape, then dried and progressively heated to approximately 1,800 deg. F., a sufficient length of time for partially fusing and vitrifying the material until a brick hardness is obtained, the interstices between the sections and those which may appear during heating being then filled with a suitable binding agent comprising bituminous material, sand and clay.

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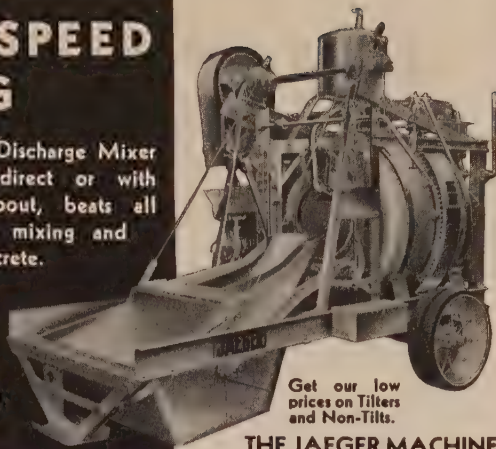
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EQUIPMENT AND MATERIALS

TWO new Branford vibrator spades, compressed air operated, have been announced by the Malleable Iron Fittings Co., Branford, Conn.

The Branford 1455-A type vibrator spade—No. 1 size—can be used in the mass between the reinforcing and the inside face of the mold. The length of the blades are 12 in. and the width 4 in.

Type 1455-B—No. 1 size—has a supplementary blade 24 in. long, 4 in. wide, corrugated, and is used as an attachment to the standard type 1455-A, to produce a smooth and voidless surface on the outside of walls, columns and the like, thus doing away with excessive patching and filling when forms are removed.

Operation is at 60 to 80 lb. maintained pressure, the makers claim. The unit operates in a horizontal position and may be



Type 1455-A, No. 1 size, Branford vibrator. The extension bar shown at the right is a 24-in. piece that may be interposed in the handle, in some cases to a depth of 40 ft., as used on caissons, columns, deep wells and the like

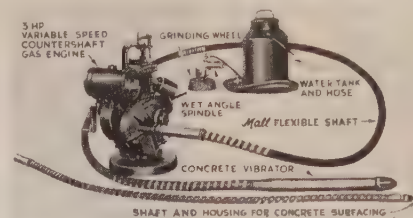
operated at as low a pressure as 20 to 30 lb., in cases where the slump is extreme and indicating a very liquid mass with, in many cases, small size aggregate.

The frequency is controlled by the valve and ranges from an idling speed of a few hundred strokes per minute up to a maximum frequency of approximately 7,500 blows per minute.

The vibrator blades are spaced so that 3-in. aggregate is cleared up to the three-spade elements that are a part of a removable housing bolted through on to the vibrator unit. These housings are renewable when worn out and a new set may be bolted to the vibrator unit which is an in-

tegral unit, complete in itself—the housing being merely a wearing piece.

MALL Tool Company, Chicago, is manufacturing a new 3 H.P. counter-shaft driven gas-engine concrete vibrating and rubbing machine. This machine has engine speeds ranging from 1,000 to 3,000 r.p.m. producing vibration frequencies from 2,000 to 6,000 per minute, which they claim



Mall concrete vibrating and rubbing machine will comply with practically all specifications for concrete placement.

For wet rubbing concrete and for the removal of board and fin marks, the low speeds are most suitable. By using fractional speed angle spindles, it is possible, they say to run the wheels as low as 150 r.p.m. This eliminates throwing the grout from the surface being finished. High speed spindles can be furnished for dry grinding.

LEE-MIX is a new one-yard transit mixer manufactured by the Lee Transit Mixer Company of Indianapolis, Indiana. The Lee-Mix unit, mounted on a low-priced, light truck chassis and operated in connection with central batcher bins, is said to cut the cost of concrete work. Power to rotate the drum is supplied by the truck motor through power takeoff. The drum rotates either forward or reverse.

Correct mixing is assured by four finger blades set at proper angles, they claim.

Lee-Mix is said to be low in first cost, economical in upkeep, fool-proof, fast in operation and adaptable to a great variety of conditions.

On jobs that require a derrick or crane, the drum may be lifted off the truck and used as a bottom dump bucket.

GAZING Globes and Sundials are said to aid the sale of concrete pedestals. Both are ornamental for the lawn, garden, pergola or arbor. A 14-in. silver sphere gives a birdseye view of the entire landscape, as one might see it from the top of a mountain.

"Atco" gazing globes and sun dials are offered by American Thermo-Ware Co., Inc., New York City.

Industrial Literature

LAMINEX Plyform is designed by the Wheeler Osgood Sales Corporation of Chicago and Tacoma, Washington, for economical and efficient concrete form construction. There is said to be unusual strength and stamina to this material—that its laminated cross grain construction makes it warp resistant and split-proof.

For monolithic concrete construction of large public buildings, residences, churches, theatres, etc., the smooth surfaces obtained are particularly desirable.

Laminex Plyform is available in panels up to 4 by 8 ft. and in thicknesses of 1/2, 5/8 and 3/4 in. for structural form boards. Thinner sheets may be obtained for form linings or for curved work.

RICKETSONS Improved Mortar Colors is the title of a new 4-page folder just issued by Ricketson Mineral Color Works of Milwaukee, Wisconsin, celebrating their 50th anniversary—1885-1935. The folder sets forth that Ricketson colors are sold internationally and carries views of important buildings in which their cement or plaster colors were used.

BINKS spray equipment is briefly outlined in Bulletin AD-114, a 2-color, 32-page booklet containing descriptions and prices of new additions to the line of the Binks Manufacturing Company of Chicago. Helpful suggestions and technical information on the proper equipment for various uses are suggested.

HARBORDATA Sheet No. 4—low cost concrete form work with Harbord Super Plycrete—giving advantages of this new product in the erecting of various types of concrete forms is being distributed by the Harbor Plywood Corporation, Hoquiam, Washington.

THE DALLETT CO., Philadelphia, makers of pneumatic tools and accessories, is distributing a new catalog of Dallett products.

There are eight pages of "Useful Information for Mechanics and Engineers."

Convey Cement Through Pipe Lines at Low Operating Cost

**Systems Well Adapted to Cement Plant Operation and Large
Construction Projects—Several Types Described**

THE great height of the circular cement-storage bins usually found at cement manufacturing plants long ago necessitated the use of a conveying system other than vertical bucket elevators.

The pneumatic cement pump was the solution to the problem which designers of cement plant equipment provided. These pneumatic pumps and their systems of pipe lines first were employed mainly in transporting cement from the tube mills to the storage bins, from the storage bins to the packing department, and from barges or railway cars to distributing warehouses. Later these pumps found employment on large construction projects, in pumping cement from railway cars or river barges to construction sites that were more or less inaccessible.

Air Is Carrying Medium

In all of the pneumatic pumping systems the cement is conveyed under the influence of compressed air, with air as the carrying medium. The velocity of the cement within the pipe line is likely to be from 60 to 80 ft. per second, the 60-ft. speed being about the lowest permissible.

The cement travels through vertical sections of pipe lines without difficulty; but on sloping sections trouble sometimes develops because of a tendency of the cement to become deposited as drifts, especially if the velocity of the moving air current is too low.

Cement has been transported by these pneumatic systems for horizontal distances of several thousand feet, and for vertical distances of more than a hundred feet. Any reasonable combination of horizontal and vertical distances is practicable.

The Fuller-Kinyon Pump

The Fuller-Kinyon pump, manufactured by the Fuller Company, Catasauqua, Penna., is one of the well-known types that is found in many cement manufacturing plants throughout the world. It was improved in several respects a few years ago. The newer unit, designated as Type F, operates under a lower air pressure than that required in the older units. As a direct result of this decreased air pressure and other improvements introduced at the same time, the power consumption of the newer type is con-

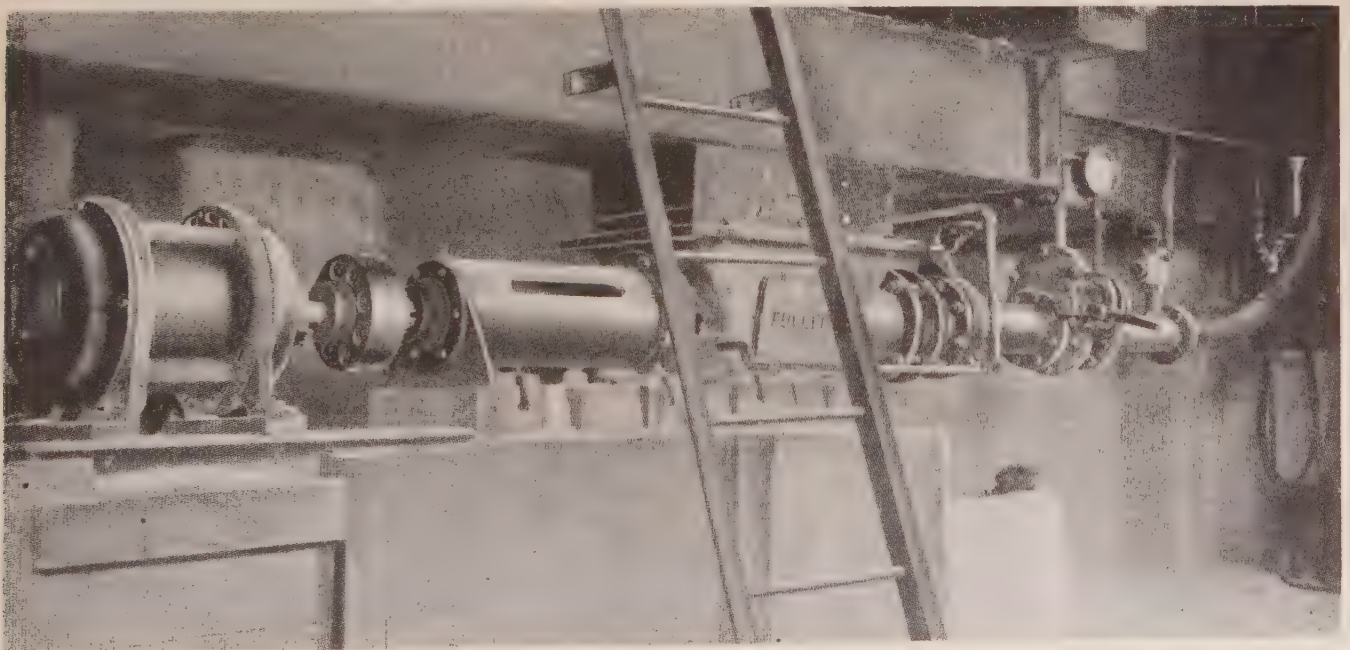


Figure 1—New Fuller-Kinyon cement pumping unit replaces older type in eastern cement plant, because of lower power requirements

siderably lower than that of the older installations. Among the mechanical differences between the old and the new units is that the improved Type F has a much shorter barrel, formed as an integral unit with the hopper, that it has an overhung impeller screw and an externally adjustable seal.

Mechanical Features

Essentially, the Fuller-Kinyon pump consists of a short length of cast steel screw conveyor, a strong spiral rotating at high speed in a completely inclosed casing. The

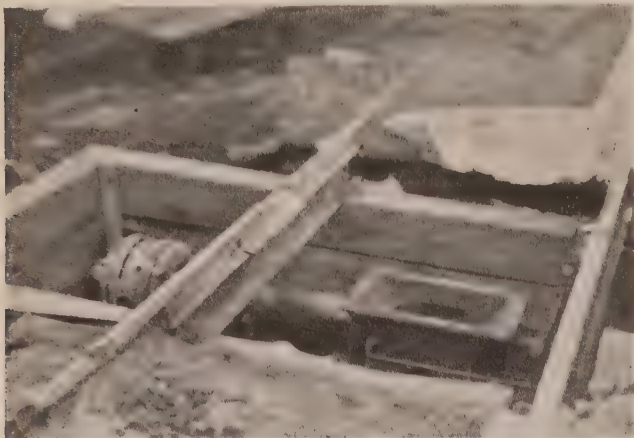


Figure 2—Typical track installation of Fuller-Kinyon pump, to receive bulk cement from bottom-discharging railway hopper cars or tank cars

cement feeds into the casing at the intake end of the spiral and is discharged into the pipe line at the opposite end. It is here, at the point of discharge, that the cement becomes intimately mixed with compressed air entering through a perforated ring.

The shaft of the screw conveyor is supported in a unitary bearing support at the rear of the hopper. Dust-sealing devices protect these bearings. The bearing assembly is aligned by means of a bushing which surrounds the shaft of the screw conveyor. The screw itself may be removed by freeing the motor coupling, displacing the transport line connection at the discharge end of the pump, then pulling the screw forward.

The pump hopper is designed so as to reduce the possibility of damage to the equipment because of the presence of tramp iron or other stray material in the cement. The pumping unit operates under an air pressure ranging from 10 to 20 lb. in the average installation.

Some Fuller-Kinyon Installations

Figure 1 shows the improved Fuller-Kinyon pump unit as installed in a cement manufacturing plant in the eastern part of this country. In this instance, as in others, it replaces an installation of the older type made by the same manufacturer.

Another use of the new Fuller-Kinyon unit is shown in Figure 2, where the pump may be seen installed under a railway track to receive bulk cement from bottom-discharging railway hopper cars or tank cars. This is the usual form of track installation, from where the cement is transported through the pipe line of the pumping system to storage warehouses, to construction sites, or whatever its immediate destination may be.

Figure 3 shows a typical distributing warehouse of a cement company—the Memphis distributing terminal of

the Marquette Cement Manufacturing Co. Fuller-Kinyon pumps deliver cement to these bins for a distance of 550 ft., from the cement company's bulk cement-carrying river barges that bring the product from its two manufacturing plants. Arrows in the illustration point to the pipe line of the pumping system.

A notable installation of the Fuller-Kinyon pumping system is that at the Davenport (Calif.) plant of the Santa Cruz Portland Cement Co., where cement is pumped to the company's bulk cement barges, through two 12-in. pipe lines, for a distance of 3,500 ft., at the rate of 400 tons an hour.

The Fluxo Pump

Another well-known pneumatic pump employed in the transporting of cement in bulk is the Fluxo pump, made by F. L. Smidth & Co., manufacturers of cement mill equipment. This pump, shown in Figure 4, is made in two types—the gravity feed and the suction feed.

The suction feed type shown in Figure 4 consists essentially of two tanks of several tons capacity, the tanks being alternately subjected to vacuum and to air pressure. While the cement is being drawn into one tank by suction, it is expelled from the other by compressed air, the air current carrying it to its destination through the pipe line that forms a part of the system. Then the cycle of operation is reversed, the tank previously under vacuum being placed under air pressure and the pressure tank being subjected to vacuum. The repetition of these cycles is



Figure 3—Arrows show pipe line of pumping system that delivers bulk cement from barges to storage terminal

automatic, once the pump is started, and the pumping of cement is continuous except for the short pauses that occur during the change-over from vacuum to pressure, and vice versa.

The gravity feed Fluxo pump has a single tank, also of several tons capacity. As the name "gravity-feed" implies, this tank is filled by gravity. When it is full, the inlet closes automatically and compressed air is automatically applied, the cement being forced through the pipe line to its destination, carried along with the current



Figure 4—The F. L. Smith Fluxo pump consists essentially of two tanks, subjected alternately to vacuum and to air pressure. A huge unit of this type delivers cement through a pipe line more than a mile long, at Boulder Dam

of air. After the tank of the pump has been emptied in this manner, the inlet opens automatically to receive the next charge. It will thus be seen that the pumping process is intermittent in the case of the gravity feed type.

Some Fluxo Pump Installations

A portable Fluxo pump of the suction feed type is in use at the Bellingham plant of the Olympic Portland Cement Co., Seattle, Wash. The pump is mounted on a carriage which operates on a track alongside the cement storage bins, where it transfers cement from one storage bin to another, from the storage bins to the adjoining packing house, and also to a more distant packing house.

At other cement plants where this type of pump is in use it is employed in the pumping of dry raw mix, in the transporting of collected dust, and pumping cement to bulk cement-carrying barges or railway cars.

Perhaps the most notable installation of the Fluxo pump is that at Boulder Canyon Dam, where a huge installation of the double-tank suction feed type pumps cement for a distance of more than one mile.

The Cera Pump

The Cera pump, another unit of European manufacture, operates in a manner somewhat similar to that of the Fluxo pump. It consists of two large containers of 2 or 3 tons capacity. The two containers are filled by gravity alternately by means of a spiral conveyor from the source of supply. When the first container is filled, the feed is automatically turned into the second, all openings and valves in the first container are closed, compressed air pressure is turned on, and the cement in the first container

is forced into the pipe line and carried to its destination. When the first container is emptied, all the valves are reversed ready for filling again as soon as the second container is full.

Robinson Air-Activated Conveyor

A recent pneumatic cement conveying system of American development is the Robinson Air-Activated Conveyor, now in use on several construction projects on the Mississippi River. The manufacturer is E. Gwynn Robinson, of New York. Simplicity is one of the merits claimed for the unit. On one of the Mississippi River projects—at Lock No. 6, at Trempealeau, Wis.—the installation consists of a tank of 300 cu. ft. capacity set beneath the railway tracks where bulk cement shipments are received.

Cement flows by gravity from the bottom-discharging hopper cars into the tank. When the tank is nearly full, the cut-off gate is shut and compressed air at a pressure of 45 lb. is admitted through an inlet manifold which has two banks of air jets reaching nearly to the bottom of the tank. This admission of compressed air through jets fluffs the cement so that it is readily expelled into the 5-in. pipe line and carried along in the air current. The cycle of operation consists of (a) filling the tank, (b) aerating the cement in the tank by admitting compressed air through jets near the bottom of the tank and (c) opening a valve in the pipe line and blowing the cement through the pipe line to its destination. The tank is then refilled. This cycle occupies about 5 minutes of time, and from this description it will be seen that delivery of cement is intermittent.

Portland Cement and Sulfuric Acid from Gypsum Anhydrite

Second Article of Series Discusses Many Operating Details of Manufacturing Process—The Flow Sheet

By DR. PETER P. BUDNIKOFF

Professor, Laboratory of Silicate Technology, Institute of Chemical Technology,
Charkoff, U. S. S. R.

In this second article of a series, the author discusses the composition of the kiln gases, the process of production, and details of the various operating departments in the production of portland cement and sulfuric acid from gypsum anhydrite.—Editor.

ACCORDING to the heat balance sheet of a rotary kiln, the theoretical consumption of coal is 24.2 per cent of the clinker, by weight. Taking into consideration also the coke consumption for the reduction of sulfate, amounting to 13.5 per cent of the weight of the clinker, the total consumption of coal will be 37.7 per cent. According to the literature, 1.17 tons of coal are needed for every 2.81 tons of clinker; or—

$$\frac{1.17 \times 100}{2.81} = 41 \text{ per cent (coal for reduction plus coal for burning)}$$

The Heat Balance Sheet

The heat balance sheet of the rotary kiln, based on the theoretical fuel consumption of 24.2 kg. for 100 kg. of clinker, will be as shown in Table 7.

TABLE 7—THE HEAT BALANCE SHEET

Source of heat, percentage of total	Heat expended, percentage of total
(1) From burning of fuel 67.6	(1) For vaporization of moisture 4.4
(2) With the air for the burning process 0.4	(2) For removal of water of hydration 0.6
(3) With the charge entering the kiln 0.5	(3) For dissociation of CaSO_4 according to the reaction: $\text{CaSO}_4 + \text{C} = \text{CaO} + \text{SO}_2 + \text{CO}$ 37.6
(4) Heat of formation of CO_2^* from CO 31.4	(4) Carried off with kiln exit gases (temp. = 750 deg. C.) 34.3
(5) With the coal required for burning 0.1	(5) Overheating of water vapor 2.3
Total 100.0	(6) Carried out by clinker (temp. = 100 deg. C.) 0.6
	(7) Carried off with clinker dust 0.1
	(8) Losses through convection and radiation 19.4
	Total 99.3

*Obtained in the process of dissociation of CaSO_4 according to the equation: $\text{CaSO}_4 + \text{C} = \text{CaO} + \text{SO}_2 + \text{CO}$.

The theoretical consumption of heat is 2,521 cal. per kg. of clinker.

The Gas Phase

For burning the mixture to portland cement clinker in a rotary kiln we took a mixture of coal consisting of 70

per cent of nut gas coal and 30 per cent of dry pulverized coal having the chemical composition of the first and second columns of figures in Table 8. The composition of the mixture of these two coals, when dried, was as given in the last column in Table 8.

TABLE 8—CHEMICAL COMPOSITION OF COAL, PER CENT

	Nut gas coal	Dry pulverized coal	Dry coal mixture
Moisture	6.00	6.50	1.00
Ash	9.00	12.00	10.50
Carbon (C)	72.10	76.20	77.60
Sulfur (S)	1.60	.60	1.40
Hydrogen (H_2)	4.10	2.80	3.50
Oxygen (O_2)	6.00	1.00	4.80
Nitrogen (N_2)	1.20	.90	1.20
Total	100.00	100.00	100.00
Calorific value, in cal./kg.	6,736	6,911	7,156

Composition of Kiln Gases

The composition of the flue gases for 1 kg. of coal, the coefficient of excess air for the burning process being $\alpha = 1.10$, is shown in Table 9.

TABLE 9—COMPOSITION OF FLUE GASES PER KG. OF COAL

	Composition, in Kg.	Percentage, by weight	Percentage, by volume
CO_2	2.845	23.95	16.34
H_2O	.376	3.16	5.13
SO_2	.028	.24	.12
N_2	8.402	70.70	76.40
O_2	.232	1.95	2.01
		100.00	100.00

Quantity of CO_2 : For 100 kg. of clinker there is required 13.5 kg. of coke, from which the following is the result:



From the subsequent burning and the consequent formation of CO_2 from CO we obtain 49.4 kg. of CO_2 .

Quantity of H_2O from Clay: To produce 100 kg. of clinker there is required 30.5 kg. of clay, which had a moisture content of 6.82 per cent.* Total water, therefore, was $30.5 \times 0.682 = 2.17$ kg.

From the mixture of raw materials an additional amount of 19.7 kg. of water is obtained, bringing the total H_2O to 21.87 kg. or practically to 21.9 kg.

Quantity of SO_2 : To produce 100 kg. of clinker, 153.6

*See Table 1 of previous installment, p. 41 of March issue of Cement Mill Edition of CONCRETE.

kg. of CaSO_4 will be required. Then the quantity of SO_2 will be:

$$\text{SO}_2 = \frac{153.6 \times 64 (\text{SO}_2)}{136 (\text{CaSO}_4)} = 72.5 \text{ kg.}$$

Quantity of Nitrogen: The oxygen from the additional air required for conversion of CO to CO_2 is shown by the equation:

$$\text{O}_2 = \frac{49.4 (\text{CO}_2) \times 16 (\text{O}_2)}{44 (\text{CO}_2)} = 17 \text{ kg.}$$

This corresponds to a quantity of nitrogen expressed by the formula $\text{N}_2 = \frac{17 \times 77}{23} = 60 \text{ kg.}$ Therefore the quantity of nitrogen is 60 kg.

As previously stated, the consumption of coal for producing 100 kg. of clinker amounts to 25 kg. From this it will be seen that the general composition of flue gases per 100 kg. of clinker will be as given in Table 10.

TABLE 10—GENERAL COMPOSITION AND VOLUME OF FLUE GASES, PER 100 KG. OF CLINKER

From products of combustion, in kg.	Total composition of gaseous products from the raw mixture, in kg.	position of products issuing from the kiln, in kg.*	Com. per-centage by weight	Volume of gases, in cubic meters	Per-centage, by volume
(1)	(2)	(3)	(4)	(5)	(6)
$\text{CO}_2 = 2.845 \times 25 = 71.1 \text{ kg.}$	49.4	120.5	24.1	61.2	17.9
$\text{H}_2\text{O} = 0.376 \times 25 = 9.4 \text{ kg.}$	21.9	31.3	6.2	37.6	11.0
$\text{SO}_2 = 0.028 \times 25 = 0.7 \text{ kg.}$	72.5	73.2	14.7	25.5	7.5
$\text{N}_2 = 8.402 \times 25 = 210.0 \text{ kg.}$	60.0	270.0	54.0	215.0	62.4
$\text{O}_2 = 0.232 \times 25 = 5.8 \text{ kg.}$	5.8	1.1	4.15	1.2	

*Note: Column (3) is the sum of columns (1) and (2).

For comparison, Table 11 shows the composition of flue gases obtained in the process here described, and from the usual method of manufacturing portland cement, as well as from mechanical kilns for roasting pyrites.

TABLE 11—COMPARISON OF COMPOSITION OF FLUE GASES

Kiln gas	Composition of gas obtained in production of portland cement and SO_2 from CaSO_4		Approximate composition of gas in the production of portland cement by usual methods.	Approximate percentage composition of gas of mechanical kilns for roasting pyrites
	Percentage, by weight*	Percentage, by volume*	Percentage, by volume	
CO_2	24.1	17.9	21.2	—
H_2O	6.2	11.0	10.5	—
SO_2	14.7	7.5	0.2	6 to 8
N_2	54.0	62.4	55.8	82.5 to 78.5
O_2	1.1	1.2	2.3	8 to 12
SO_2	—	—	—	About 1.5

*These values are taken from Table 10.

In the course of accomplishing technical analyses of exit gases from a rotary kiln with the aid of Orsat or Norse apparatus, the greater part of the steam obtained

from the combustion of fuel and from the kiln charge is condensed before it enters the apparatus. This leads to the fact that the gases subjected to the volumetric analysis are almost completely dehydrated. This being the case, the concentration of the remaining gases increases after the elimination of one of the components from the gas mixture.

It can be concluded from the above that the concentration of SO_2 in kiln-exit gases which contain a considerable quantity of water is lower than the concentration shown by the gas analysis, because the kiln-exit gases enter the gas analyzer in a considerably dehydrated condition. If the gases containing water vapors carry 7.5 per cent of SO_2 , by volume, and 11.0 per cent of water vapor, calculating on the basis of "dry" gases, we will obtain $\frac{7.5 \times 100}{89} = 8.48$ per cent of SO_2 by volume, or 15.6 per cent by weight.

Increasing the coefficient of excess air needed for combustion in the rotary kiln to $\alpha = 1.3$ and 1.5 will lead to

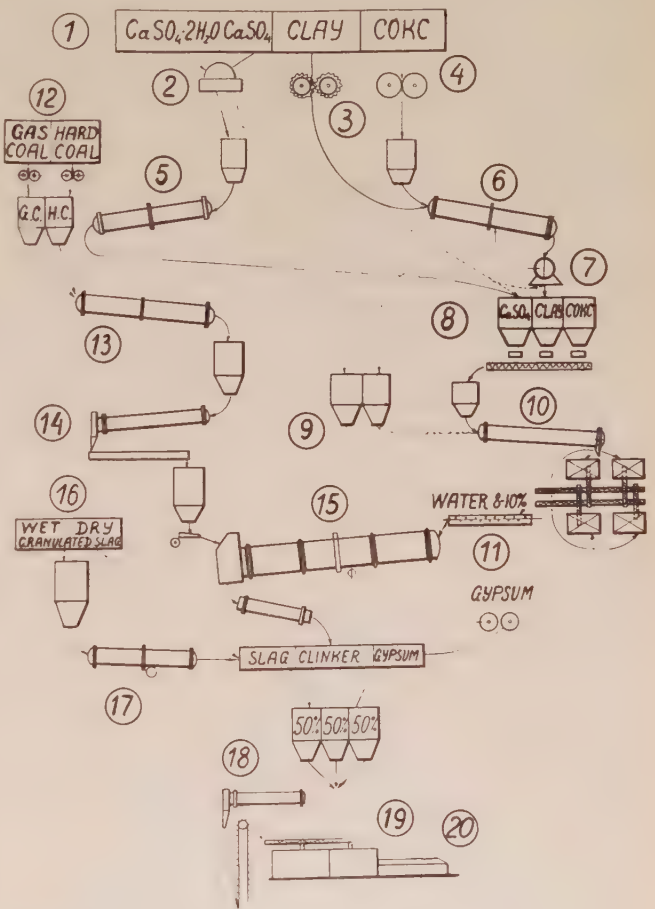


Figure 2—Flow sheet for production of portland cement and sulphuric acid

1. Raw materials storage

2. Hammer mill

3. Wolf machine

4. Ribbed rollers

5. Drying drum

6. Drying drum

7. Disintegrator

8. Weighers

9. Silos for correction of mixture

10. Dry grinding mill
11. Moistening conveyor worm

12. Coal storage

13. Drying drum

14. Coal mill

15. Rotary kiln

16. Slag storage

17. Drying drum

18. Cement mill

19. Silos

20. Packing department

the composition of kiln-exit gases shown in Table 12, as compared with the case where the coefficient is 1.1.

TABLE 12—EFFECT OF INCREASING EXCESS AIR

	Coefficient of Excess Air		
	1.1 per cent	1.3 per cent	1.5 per cent
Carbon dioxide (CO ₂)	17.9	16.2	15.2
Water (H ₂ O)	11.0	9.9	9.4
Sulfur dioxide (SO ₂)	7.5	6.8	6.4
Nitrogen (N ₂)	62.4	64.0	64.9
Oxygen (O ₂)	1.2	3.1	4.1

From the total raw material burned in the rotary kiln we will obtain the quantities of SO₂ and H₂SO₄ (monohydrate) shown in Table 13, expressed in tons.

TABLE 13—QUANTITIES OF SO₂ AND H₂SO₄, IN TONS

	Per hour	Per day	Yearly
Sulfur dioxide (SO ₂)	3.02	73.2	21,600
Sulfuric acid (H ₂ SO ₄)	4.60	110.1	33,100

In this way the plant can produce yearly about 33,000 tons of sulfuric acid (monohydrate), and 30,400 tons of portland cement clinker, or 400,000 bbl. of slag-portland.

As regards the choice of a system for producing sulfuric acid, we think it more expedient to select the Peterson tower system, the productivity of which fully corresponds with the quantity of sulfurous gas. This system, as is known, is not sensitive to the fluctuations in the composition of flue gases such as inevitably will occur during the process of production. On the other hand, the contact method of oxidation of sulfurous gas with the aid of a vanadium catalyst is not eliminated.

Process of Production

The plant produces yearly 400,000 bbl. of slag-portland cement (50 per cent portland cement clinker and 50 per cent basic granulated blast-furnace slag), and about 33,100 tons of sulfuric acid (monohydrate).

The raw materials were fully described in last month's issue of the *Cement Mill Edition* of CONCRETE, pages 40 to 42. The plant must operate uninterruptedly throughout the whole year. Capacity of the various kinds of machinery selected is such as to provide the time needed for the repair of equipment. Accordingly, the schedule given in Table 14 may be assumed.

TABLE 14—NORMAL OPERATING SCHEDULE FOR YEAR

Mills	300 days at 21 hrs. = 6,300 hrs. per year
Kilns	300 days at 24 hrs. = 7,200 hrs. per year
Dryers	300 days at 24 hrs. = 7,200 hrs. per year
Coal preparation department	300 days at 24 hrs. = 7,200 hrs. per year
Packing department	300 days at 7 hrs. = 2,100 hrs. per year

Taking into consideration the experimental character of the plant, the sizes and capacities of the various equipment and handling units were selected so as to allow for variations in the normal operating schedule, in either direction. The flow sheet for the production of portland cement and sulfuric acid is shown in Fig. 2.

Raw Materials Department

The tonnage of raw materials required to keep up with the production schedule is shown in Table 15.

TABLE 15—RAW MATERIAL REQUIREMENTS, IN TONS

	Per hour	Per day	Per year
Raw gypsum	8.40	186.24	55,935
Raw clay	1.59	33.60	10,085
Raw coke waste	0.67	14.05	4,228
Totals	10.66	233.89	70,248
Anhydrite	7.30	153.6	46,440
Dry clay	1.48	31.0	9,338
Dry coke waste	0.65	13.7	4,105
Totals	9.43	198.3	59,883

The storehouse for raw materials (gypsum, clay and coke waste) is calculated for a 14 days' reserve.

Raw gypsum arriving from the storehouse is crushed in a hammer mill with an output of 12 tons per hour of crushed material (30 per cent reserve capacity). The power required is 12.5 hp. The crushed material is conveyed in a bucket elevator to a bunker situated over the drying drum.

Feeding of the drum with gypsum is accomplished with the aid of a feeding plate. For drying gypsum there is installed a counter-current drying drum with a cooler 7 ft. 2 in. in diameter and 72 ft. 2 in. long. Power requirements are 11 hp., and the normal output is 10.4 tons per hour of dry gypsum (reserve capacity of 30 per cent). Drying of the gypsum in the drying drum is accomplished at 550 to 600 deg. C. From the drying drum the anhydrous gypsum (anhydrite) is conveyed directly to the storage silo.

In the case of a plant using natural anhydrite this will be crushed in the hammer mill and, passing over the drying drum, will be transported directly to the dosing bunker.

Clay and Coke

Raw clay arriving from storage with a moisture content of 8 per cent is crushed in a wolf machine (toothed rollers). Its output is 6.0 tons of raw clay per hour, and power consumption is 5 hp. From the wolf machine the clay is transported by a belt conveyor direct to the charging opening of a drying drum. The clay is dried in a counter-current drying drum 6 ft. 7 in. in diameter and 59 ft. long, with power requirements of 9.0 hp. and an output of 2.2 tons per hour (32.5 per cent reserve capacity).

Inasmuch as the quantity of coke waste required is small (0.65 tons per hour), no special drying drum is installed for this material. All coke waste is dried in the same dryer as the clay (2 days being given over to the drying of clay, and one day to coke waste).

The dried clay is crushed in a disintegrator having a drum diameter of 2 ft. 11½ in., a power requirement of 13.0 hp., and a normal output of 2.5 tons per hour (40 per cent reserve capacity). From the disintegrator the clay is conveyed in an elevator to the dosing bunker.

The coke waste arriving from storage with a moisture content of 3 to 5 per cent is subjected to preliminary crushing in ribbed rollers, after which it is conveyed in an elevator to a bunker of 10 hours' work capacity, situated above the drying drum. The dried coke waste, after being dried, is elevated to the dosing bunker.

The dosing bunkers for dry materials (anhydrite, clay and coke) are designed for a 10 hours' supply. To maintain a more exact relation between the different components the dosing is accomplished by means of an automatic weighing balance.

The proportioned materials enter a conveyor worm for a preliminary mixing, from where they are conveyed to a bunker over the mill for dry grinding. The capacity of this bunker is calculated for 10 hours' operations. For the purpose of correcting the composition of the dry mixture, two supplementary bunkers for anhydrite and clay are installed near the bunkers over the mill. These supplementary bunkers have a capacity of 20 tons.

Final Grinding of Raw Material

For the final grinding of the raw mixture there is installed a one-chamber Polysius tubular mill for dry milling. This mill has a diameter of 6 ft. 7 in. and a length of 39 ft. 4 in. Its power requirements are 400 hp., and its normal output is 15 tons per hour of dry mixture (37 per cent reserve capacity). This capacity is on the basis of grinding to a fineness corresponding to a residue of 10 per cent on a 4,900-mesh sieve (178 meshes per lin. in.). The feeding of the mill is aided by a plate feeder.

We think that the combined grinding of the dry mixture of burned gypsum with clay and coke in a tubular mill is the most expedient, because this method leads to a more uniform distribution of the pulverized coke in the dry mixture.

The milled mixture is transported to the storage silos for the dry mixture (not shown on the flow sheet). These silos are four in number, each having a capacity of 180 cubic meters. This provides practically a 4 days' supply, the daily consumption of dry mixture being 198.3 tons.

To insure uniform feeding of the dry mixture from the silos and its transportation to the kiln, there are installed four double raking conveyor worms (not shown in the flow sheet) and two elevators in which the dry mixture is lifted into the bunker over the moistening conveyor worms that feed the rotary kiln. The capacity of this bunker is calculated to hold a 10 hours' supply.

Coal Department

Table 16 discloses the coal requirements, expressed in

TABLE 16—COAL REQUIREMENTS, IN TONS

	Per hour	Per day	Yearly
Moist coal	1.15	27.50	8,360
Dry coal	1.06	25.40	7,620

tons. For burning the raw meal to clinker, the coal used is a mixture consisting of 70 per cent of nut gas coal and 30 per cent of dry pulverized coal (see Table 8, last column).

Coal storage capacity is calculated for a 15 days' supply. Upon arriving from storage the coal is crushed in ribbed rollers, from where it is conveyed to the bunkers over the drying drum. With the aid of feeding plates the coal is then fed direct to the drying drum.

The drying of coal is accomplished in an American type drum having a diameter of 6 ft. 7 in. and a length of 55 ft. The heating tube has a diameter of 2 ft. 7½ in. Its power requirement is 14.0 hp. At a moisture content of 8 per cent the drying capacity of the drum is 8 tons of coal per hour. Thus the capacity of the drum is sufficient to dry the required amount of coal, even if the moisture content should run to 20 or 25 per cent.

During the dry season of the year the moisture content of the coal is so low that it may be possible to feed it directly to the mill, thereby omitting the coal-drying operation.

From the drying drum the coal is conveyed through a worm and an elevator to the bunker over the mill. This bunker contains storage capacity for a 10 hours' supply. From the bunker the coal is fed to the mill with the aid of a feeding plate.

Grinding of Coal

For the grinding of the coal a 3-compartment mill is installed, the diameter of which is 5 ft. and the length 26 ft. 3 in. The power requirement is 225 hp., and the capacity is 4.5 tons of coal per hour when the fineness of grinding runs around 9 to 10 per cent retained on the 4,900-mesh sieve (178 meshes per lin. in.).

To facilitate continuous operation of the kiln, a reserve bunker for pulverized coal is installed. This supplementary bunker (not shown on the flow sheet) holds a 12-hour supply.

From the main bunker the pulverized coal passes through a distributing valve to the working bunker, which holds a 4-hour supply. From here it passes through a double feeding conveyor worm to a pipe line, through which it is blown into the kiln.

Collection of dust from the coal department and from the dust-laden flue gases originating in the drying drum is accomplished by means of a common cyclone dust collector. The collected dust (finely pulverized coal) is conveyed to the reserve coal bunker.

Kiln Department

Feeding of the raw meal to the rotary kiln is accomplished with an ordinary moistening-blade conveyor worm having a diameter of 2 ft. 8 in. and a length of 13 ft. 2 in. To insure an uninterrupted feeding of the kiln in case of breakage of the moistening worm, a second worm of the same dimensions is installed alongside the first.

The water required for the moistening of the dry mixture equals 10 per cent of the weight of the dry mixture. In consequence, the quantity of water required is 0.943 cubic meters per hour, 19.83 per day, and 5,988 cubic meters per year.

Table 17 sets forth the normal output of the rotary

TABLE 17—NORMAL OUTPUT OF ROTARY KILN

	Per hour	Per day	Per year
Clinker, in tons	4.23	101.52	30,400
Clinker, in barrels	28	6,560	200,000

kiln, expressed in tons and in barrels. The rotary kiln has a diameter of 9 ft. 10 in., and a length of 168 ft. It rests on four supports. Its normal yearly output, as indicated in Table 17, is 200,000 bbl. of clinker (50 per cent of the usual output of portland cement). The sintering zone is 18 ft. long. The kiln is equipped with an open-type clinker cooler 7 ft. in diameter and 67 ft. long. Power required is 40 hp. for the kiln and 20 hp. for the clinker cooler. The temperature in the hottest zone of the kiln is about 1,450 deg. C. (2,640 deg. F.). The material remains in the kiln about 4 hours, this relatively long time being attained by reducing the speed of rotation of the kiln to about half the usual speed.

As regards the lining for the sintering zone of the kiln and the zone of maximum dissociation of CaSO₄, our investigations disclose that the greatest chemical resistibility is possessed by good chromite-magnesite brick of the "Radex" type. On the other hand, high chemical resistibility is disclosed by high-alumina brick also. The usual silica brick deteriorates quickly. Magnesite brick, though a chemically resistant material, has a tendency toward spalling.

(To be concluded)

EDITORIAL

Helping the Cement Industry

The work-relief bill is in the hands of the House-Senate conference committee as this issue is going to press, and final passage is expected to occur within a short time; and the cement industry has much to hope for in the expenditure of the various funds included in this \$4,000,000,000 appropriation.

While it is true that much of the work contemplated will be of a nature that will require little concrete, other activities will utilize large quantities of this material.

For instance, there is the special allocation of 450 millions to continue the large-scale housing projects of the PWA's housing division. Another allocation of 900 millions is ear-marked for public works construction by states and municipalities—an allocation that means the building of dams, sewage disposal plants and sewerage systems, pumping stations and reservoirs, grade separation structures, street pavements, and other useful public works.

Money will be expended also on the highway construction program, not only from this appropriation, but from funds provided by previous sessions of Congress; and this means more roads, and more bridges and grade-elimination structures.

Development of the water-conservation program will involve the relocation of railroads and highways, along with the necessary bridges, and the moving or reconstruction of buildings.

The cement industry will be certain to win a reasonable share of the business resulting from this great national effort.

Foreign Cement a Menace Again

Charles L. Hogan, president of the International Cement Corp., recently expressed the feeling of the cement industry

in general toward the action of the Secretary of State in negotiating the reciprocal trade agreement with Belgium, whereby the tariff on cement imported from that country is reduced by 25 per cent.

Fear of wholesale dumping in the coastal markets, and of a further detrimental effect if similar treaties are concluded with other favored nations, was expressed by Mr. Hogan.

While the general opinion is that Belgian cement manufacturers will make no serious effort to invade the American market during the present low level of demand, this lowering of the duty that was already too low may result in heavy foreign imports of cement during future periods of increased demand. An immediate effect may be a slowing down in the placement of orders from material dealers, who may delay

action in the hope that prices will be reduced.

The meager tariff of 23 cents a barrel, now reduced to 17 cents on Belgian cement, will offer little resistance if foreign manufacturers undertake any sustained invasion of the American coastal market.

Just why this special favor should be granted to debt-defaulting Belgium, and why a commodity having but little tariff protection should be selected as the sacrifice on the altar of reciprocal trade agreement, are points that have not been made clear. The leaders of the cement industry have a difficult problem on their hands.

Portland Cement from Anhydrite

The articles by Dr. Budnikoff starting in the March issue, on the manufacture of portland cement and sulfuric acid from gypsum anhydrite, are well worth

careful study by cement men in this country. Dr. Budnikoff is at present engaged in the construction of a plant where the process he describes will be employed.

Anhydrite (CaSO_4) is the anhydrous form of calcium sulfate, and is found in natural beds in close association with beds of gypsum ($\text{CaSO}_4 \cdot \text{H}_2\text{O}$), the hydrous form of calcium sulfate.

Anhydrite, as such, is found in relatively small quantities in comparison with gypsum. In Dr. Budnikoff's process, however, he converts the hydrous form into anhydrite by burning the natural gypsum at a temperature of about 600 deg. C., thus driving off the water of crystallization.

The initial raw materials to be used in the plant now under construction will be clay and natural gypsum rock. The gypsum rock, as stated, is burned at 600 deg. C. for a period of one hour, and the clay is dried in the usual manner. The two materials are then mixed, together with a small quantity of coke waste, and the mixture is ground to a fineness that leaves no residue on the 76-mesh sieve, and about 8 per cent residue on the 178-mesh.

This prepared raw material is then burned to cement clinker by the fractionated method of burning, first at 1,200 deg. C. for 2 hours, after which the temperature is gradually increased to 1,420 deg. C. This fractionated method of burning lowers the quantity of CaSO_4 in the clinker obtained.

The sulfuric acid is produced, of course, by recovering the large quantity of sulfur dioxide from the kiln-exit gases and converting it into sulfuric acid.

The process is not complicated. Concerning the cost of portland cement produced in this manner, as compared with the usual methods, this can be determined only from a thorough investigation.

Altering Compound Mills to Improve Grinding

By RUDOLF ZOLLINGER
(In *Cement and Cement Manufacture*, November, 1934)

THE question of the best degree of grinding for cement has not yet been decided. Theoretically, the quality of cement should improve with increasing fineness, and, generally speaking, this is the case, as is shown by test results given in Table I. The figures in the table refer to one cement ground to different degrees of fineness under the same conditions.

TABLE I

Per cent resi- due on 180-mesh sieve	Tensile strength in lb. per sq. in. at			Crushing strength in lb. per sq. in. at		
	3 days	7 days	28 days	3 days	7 days	28 days
10	260	313	370	2,332	2,915	4,650
8	242	350	420	2,332	5,517	6,826
6	271	317	459	1,905	4,749	7,650
4	336	398	441	2,403	5,916	7,537
2	299	378	483	5,162	6,783	7,906
1	—	464	526	—	5,873	9,954
0	359	449	530	5,930	7,224	9,499

In many cases, however, an increase of fineness above a certain limit causes a reduction in strength, which varies for different cements, i.e., with some cements the reduction sets in earlier than with others. It is thus necessary to determine the most favorable fineness in each case. In the case of cement raw materials fineness cannot be taken too far, and its limit is only determined by economic considerations; but for cement other factors about which very little has hitherto been known enter into the question.

Excessive Grinding

By the separation of lime with the

mixing water a colloidal mass of calcium hydrate is formed in which the residual constituents are embedded. If we consider that with increasing fineness the particles become increasingly more spherical in shape, and that the sphere is the body of minimum surface, it is conceivable that this reduction in the surface of individual particles may be accompanied by a reduction in the power of attack of the mixing water. Thus, setting will be retarded, or may even remain incomplete.

The reduction in strength with continued grinding is most evident with cements in the grinding of which separators have been used. The product of a grinding plant employing methods of separation is distinguished from that of the compound mill by a more uniform grain size. The importance of proper grading of the aggregates in the production of strong concrete is well known. In the same way the residual cement forms a "concrete" with the calcium hydrate, which may offer some explanation of this phenomenon.

The theory has been advanced, particularly by Helbig, that the reduction in strength is entirely due to the combination of the finest particles, even before the cement is mixed, with the moisture which is everywhere present. Practical considerations indicate, however, that the explanation lies in the fact that a cement of mixed grain size gives better strength. Technically, the

required conditions are best attained with the compound mill, which, as a result, dominates in grinding cement, while the field of the separator lies in grinding raw materials.

How Fine?

The question of how fine to grind is an economic one in the case both of raw materials and of cement. Cement grinding requires more power than raw materials, and increasing the fineness is only reasonable up to a certain limit. Table I shows that for the cement in question the limit is reached at 1 per cent residue on the 180-mesh sieve; further grinding to 0 per cent residue is in this instance waste of power.

While the separator allows practically any fineness to be obtained with the simplest plant, conditions are very different with the compound mill. In this case there is no removal of the finest fraction, and, if this is continuously ground, under certain conditions it becomes dead-ground, in that the grinding media pound it into scales which possess no useful strength.

Fine grinding also affects setting time. At first setting time increases with fineness, but beyond a certain limit of fineness setting time is slowly reduced. It would appear that the heat generated in the mill is the sole cause of this phenomenon. In grinding to increased fineness the mill out-

(Continued on page 46)

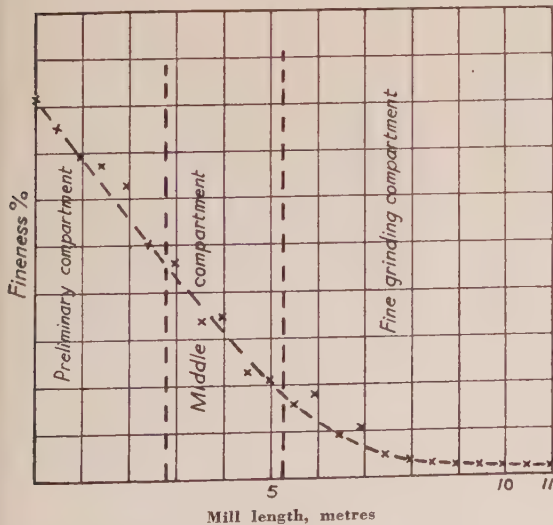
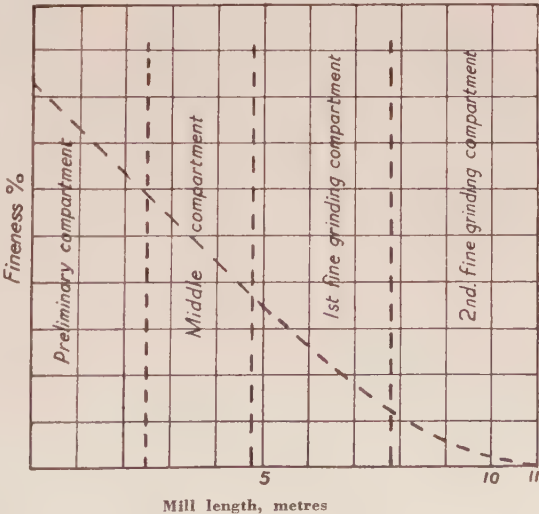


Fig. 1 (left) shows the grinding curve for a compound mill

Fig. 2 (right) shows curve after alterations, the mill now being uniformly used along its whole length



Heats of Formation of Tricalcium and Dicalcium Silicates

New Contribution to Cement Research Presented by Well-Known Investigators at University of Saskatchewan—
Results of Investigation Summarized¹

By O. K. JOHANNSON and T. THORVALDSON

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THE only data found in the literature from which the heat of formation of tricalcium silicate can be calculated are those obtained by D. Tschernobaeff² by firing mixtures of calcium carbonate and silica (quartz) with charcoal in a bomb calorimeter. The average value obtained for the reaction between the calcium carbonate and the silica was 107.9 kg.-cal. absorbed per mole of tricalcium silicate. Assuming that on dissociation of calcium carbonate 42.7 kg.-cal. per mole are absorbed, the value obtained for the heat of formation of tricalcium silicate from calcium oxide and quartz is 20.2 kg.-cal. per mole or 88.5 g.-cal. per gram of tricalcium silicate. Tschernobaeff states that the reaction product contained both some combined carbon dioxide and "a great amount of free lime."

Tschernobaeff and Wologdine³ used the same method to determine the heat of formation of dicalcium silicate. Their calculated value for the heat of formation from calcium oxide and silica (sand) was 28.7 kg.-cal. per mole of Ca_2SiO_4 .

Nacken⁴ determined the heat of solution of γ -dicalcium silicate in a mixture of hydrochloric and hydrofluoric acids. The analysis of the artificially prepared silicate, the concentration of the solution of acids and the temperature of the determinations are not given. The average value recorded for the heat of solution was 537.304 calories per gram or 92.671 kg.-cal. per mole of γ -dicalcium silicate. From this value and the heat of solution of an equivalent amount of lime and silica

in the same mixture of acids, Nacken calculated the heat of formation of γ -dicalcium silicate from lime and silica as 209.396 cal. per gram or 36.109 kg.-cal. per mole. This value differs widely from the 28.7 kg.-cal. per mole obtained by Tschernobaeff and Wologdine.³

Apparatus and Experimental Procedure

The calorimeter, which was of the Richards adiabatic type with slight modifications, the Beckmann thermometers used, the method of introducing the sample into the calorimeter and the limits of adiabatic control have been described elsewhere.⁵ One new modification was introduced during this work. The rotary gold stirrer used to agitate the liquid contained in the gold calorimeter was driven by means of a small synchronous motor.⁶ With careful regulation of the thermal head of the calorimeter jacket, the temperature rise due to stirring and transference of heat during thirty-minute periods was found to check within ± 0.001 deg., or ± 0.00003 deg. per minute. All the work was done in a room maintained at a constant temperature of 21 deg. All weights were compared with a U. S. Bureau of Standards absolute standard and corrected to vacuum.

The silicates studied were gamma-dicalcium silicate, beta-dicalcium silicate and tricalcium silicate. The general procedure used was to determine the heat of solution (or decomposition) of the silicate in acid of the concentration $\text{HCl} \cdot 20\text{H}_2\text{O}$. The heats of dilution of the acid and of the resulting solution (containing the liberated silica gel) when diluted to a concentration corresponding to $\text{HCl} \cdot 200\text{H}_2\text{O}$ were then determined by the method of Richards, Rowe and Burgess,⁷ and the heat of solution (or decomposition) of the silicate in $\text{HCl} \cdot 200\text{H}_2\text{O}$ calculated according to the usual method.⁷ From this result and the known heat of solution of calcium oxide in $\text{HCl} \cdot 200\text{H}_2\text{O}$ ^{5a} the heat of formation of the respective silicate from calcium oxide and silica gel was then calculated. The latent heat of transition of the beta to the gamma form of dicalcium silicate was also calculated.

Decomposition of Silicates

About 95 to 99 per cent of the total rise of temperature occurs, under the conditions of the experiments, during the first thirty

minutes after the introduction of the finely powdered silicate into the acid in the calorimeter. Then follows a considerable interval, the length of which varies somewhat with different samples of the silicate, during which the rate of rise is considerably in excess of the initial rating for the heat of stirring. During this period, the rate of rise decreases slowly until it is equivalent to the initial rating. The possibility that this slow rise might be due to changes in the heat of stirring during the determination was excluded by experiments showing (1) that the viscosity of the calorimeter liquid did not vary appreciably and (2) that the presence of the silica in suspension did not affect the heat of stirring.

The decomposition of the silicate was shown to be complete by the absence of non-volatile impurities in the precipitated silica (on treatment with hydrofluoric acid). Experiments with a solution of sodium silicate, in place of the solid silicate of calcium, demonstrated that at least a considerable portion of the slow rise after the first thirty minutes of a determination must be due to the thermal changes in the silica after the decomposition is completed. While the time required from the introduction of the sample until the rate of rise in temperature reached the initial stirring correction varied from one and one-half to three hours, the experiments were always continued for an hour to an hour and a half longer. With the synchronous motor and such long initial and final rating periods, the possibility of slow thermal changes equivalent to more than 0.00002 deg. per minute was excluded definitely.

Preparation of the Silicates

Finely ground mixtures of calcium carbonate and silica in the proper proportions were moulded into hollow cylinders. These were dried and then fired, supported on a disk of magnesium oxide, in a compressed air-oil furnace at temperatures between 1,500-1,600 deg. until well sintered. The cylinder was then either allowed to dust (in the case of dicalcium silicate) or crushed in a tool steel mortar, any steel removed by a magnet, and the product ground in an agate mortar to pass a 200-mesh sieve. The cylinder was then remade and refired until a satisfactory product free from uncombined lime was obtained.^{8,9} In preparing the tricalcium silicate the lime content was increased gradually according to the method described by Lerch and Bogue.¹⁰

¹ From reprint from the Journal of the American Chemical Society, 56, 2327 (1934), issued by the Department of Chemistry, University of Saskatchewan.

² D. Tschernobaeff, *Revue de Metallurgie*, 2, 729 (1905).

³ Tschernobaeff and Wologdine, *Compt. rend.*, 154, 206 (1912).

⁴ Nacken, *Zement*, 19, 818, 847 (1930).

The usual method of preventing the transition of β - Ca_2SiO_4 to γ - Ca_2SiO_4 is to add either boric acid or chromic oxide and to quench the product. Such additions are undesirable in the case of thermochemical material. An intimate mixture of pure calcium carbonate and very light silica gel gave after one firing a product which did not invert to the γ -form on rapid quenching. This sample (β - CaSiO_3 "A") was very pure, contained no free lime and only traces of the γ -form and free silica.

It was also found that the β -form could be prepared entirely free from any of the γ -variety by heating a sample of the latter, ground to pass a 200-mesh sieve, at about 1,000 deg. for several hours and then cooling rapidly to room temperature. This is probably due to the decrease in the rate of conversion on account of the less intimate contact of the crystals in this fluffy material. Sample β - Ca_2SiO_4 "B" was prepared in this way from γ - Ca_2SiO_4 Sample "A." These two samples have therefore identical chemical composition and the results obtained with them give directly the heat of transition of the β to the γ -form.

The authors are indebted to Dr. V. A. Vigfusson for careful microscopic examination of the substances prepared. The refractive indices were carefully checked in each case.

The analyses of the various samples are given in Table I as well as a calculation of the compounds present as impurities in each sample by a method similar to that of Bogue.¹¹ Certain evident assumptions as to the compounds present in each case are made.

The Determination of the Heats of Decomposition of the Silicates in $\text{HCl} \cdot 20\text{H}_2\text{O}$ and in $\text{HCl} \cdot 200\text{H}_2\text{O}$

Tables II and III give a summary of the experimental results and the calculations of the heats of decomposition of the pure silicates. For a detailed example of the method of calculating the heat of decomposition of a silicate in $\text{HCl} \cdot 200\text{H}_2\text{O}$ from its heat of decomposition in $\text{HCl} \cdot 20\text{H}_2\text{O}$ and the heats of dilution of the initial and the final systems, the reader is referred to a similar case, an aluminate of calcium, in a previous paper of this series.^{5c}

For the purpose of calculating the heat of decomposition of a pure sample of the silicate in $\text{HCl} \cdot 200\text{H}_2\text{O}$, it is assumed that the heats of decomposition or solution of the components of a mixture in acid of this dilution are additive. It has been shown repeatedly that the mixing of hydrochloric acid solutions of this concentration with similar solutions in which a portion of the acid hydrogen has been replaced by a metal does not give an appreciable thermal effect. However, should there be any tendency for the formation of solid solutions such admixtures

may affect the value of the lattice energy of the solid. The agreement of the calculated results for the heat of decomposition of pure β -dicalcium silicate from the experimental results for samples "A" and "B" and the similar agreement in the case of the two products containing mainly tricalcium silicate indicate that such an effect is not marked for these silicates.

TABLE I—ANALYSES OF THE SILICATES^a
(ANHYDROUS BASIS)

	β -Dicalcium silicate "A"	γ -Dicalcium silicate "B"	Tricalcium silicate "A"	Tricalcium silicate "B"
SiO_2^b	34.45	34.99	26.71	26.64
CaO^c	64.17	62.62	72.52	71.97
Al_2O_3	0.75	1.14	0.76	0.80
Fe_2O_3	Trace	Trace	Trace	Trace
MgO	0.50	1.29	0.26	0.57
Free SiO_2	0.19	—	Trace	0.05
	100.06	100.04	100.25	100.03
MgO	0.50	1.29	0.26	0.57
SiO_2	0.19	—	Trace	0.05
$\text{CaO} \cdot \text{Al}_2\text{O}_3$	1.16	1.76	—	—
$3\text{CaO} \cdot \text{Al}_2\text{O}_3$	—	—	2.01	2.12
$\text{CaO} \cdot \text{SiO}_2$	1.20	6.92	—	—
$2\text{CaO} \cdot \text{SiO}_2$	97.01	90.07	10.90	12.21
$3\text{CaO} \cdot \text{SiO}_2$	—	—	87.08	85.08
	100.06	100.04	100.25	100.03

^a The analytical procedure was that recommended by Hillebrand and Lundell, "Applied Inorganic Analysis," John Wiley and Sons, 1929.

^b Total silica less silica in "insoluble residue," determined according to U. S. Gov. specification for portland cement.

^c None of the samples contained any free calcium oxide.^{8,9}

Approximate values for the heat of solution or decomposition of tricalcium aluminate, monocalcium aluminate, monocalcium silicate and magnesium oxide in $\text{HCl} \cdot 200\text{H}_2\text{O}$ were necessary for these calculations. The first has already been determined^{5c} (733 cal. per g.). Approximate values for the second and third were determined (636 and 191 cal. per g., respectively) and a value for magnesium oxide (812 cal. per g.) was calculated from available data.¹²

Calculation of Heats of Formation and Transition

Taking the average value for the heat of decomposition of β -dicalcium silicate Samples "A" and "B," namely, 347 g.-cal. per gram or 59.76 kg.-cal. per mole, and the value 56.50 kg.-cal. per mole for the heat of solution of calcium oxide in $\text{HCl} \cdot 200\text{H}_2\text{O}$,^{5a} one obtains the figure 33.24 kg.-cal. (139.0 kj.) per mole or 193.0 g.-cal. (807 j.) per gram for the heat of formation at

20 deg. of β - Ca_2SiO_4 from calcium oxide and silica gel.

From the value 341.0 g.-cal. per gram or 58.73 kg.-cal. per mole, for the corresponding heat of decomposition of γ -dicalcium silicate in $\text{HCl} \cdot 200\text{H}_2\text{O}$, one obtains the figure 34.27 kg.-cal. (143.3 kj.) per mole or 199.0 g.-cal. (832 j.) per gram for the heat of formation at 20 deg. of γ - Ca_2SiO_4 from calcium oxide and silica gel.

From the above one obtains the value 1.03 kg.-cal. (4.3 kj.) per mole or 6 g.-cal. (25 j.) per gram for the heat of transition at 20 deg. of the β to the γ -form of dicalcium silicate. This is in qualitative agreement with the fact that γ -dicalcium silicate is the stable form at ordinary temperatures. The value obtained directly from the data for β -dicalcium silicate "B" and γ -dicalcium silicate "A," i. e., 5.5 g.-cal. (23 j.) per gram, may be more reliable since these samples are of identical chemical composition.

From the value 467.5 g.-cal. per gram or 106.73 kg.-cal. per mole for the heat of decomposition of tricalcium silicate in $\text{HCl} \cdot 200\text{H}_2\text{O}$ one obtains the figure 32.77 kg.-cal. (137.0 kj.) per mole or 143.5 g.-cal. (600 j.) per gram for the heat of formation at 20 deg. of tricalcium silicate from calcium oxide and silica gel.

While the formation of these silicates from calcium oxide and silica gel involves the evolution of heat, one finds from the data for the heats of solution that the formation of tricalcium silicate from calcium oxide and β -dicalcium silicate involves the absorption of 0.47 kg.-cal. (2.0 kj.) per mole or 2.06 g.-cal. (8.6 j.) per gram, the corresponding figures with γ -dicalcium silicate being an absorption of 1.50 kg.-cal. (6.3 kj.) per mole or 6.59 g.-cal. (27.5 j.) per gram of trical-

⁵ (a) Thorvaldson, Brown and Peaker, This Journal, 51, 2678 (1929); (b) Thorvaldson and Brown, *ibid.*, 52, 80 (1930); (c) Thorvaldson, Brown and Peaker, *ibid.*, 52, 3927 (1930).

⁶ E. L. Harrington, American Physics Teacher, Dec., 1934. The authors wish to express their indebtedness to Professor Harrington for supplying this motor.

⁷ Richards, Rowe and Burgess, This Journal, 32, 1176 (1910).

⁸ A. H. White, J. Ind. Eng. Chem., 1, 5 (1909).

⁹ Lerch and Bogue, *ibid.*, 18, 739 (1926); *ibid.*, Anal. Ed., 2, 296 (1930).

¹⁰ Lerch and Bogue, J. Phys. Chem., 31, 1627 (1927).

¹¹ Bogue, Ind. Eng. Chem., Anal. Ed., 1, 192 (1929).

¹² "I. C. T.," 1929, Vol. V, pp. 176 and 195.

TABLE II—HEATS OF DECOMPOSITION OF DICALCIUM SILICATE AND TRICALCIUM SILICATE IN HCl.20H₂O

Description of sample	Detns.	Av. wt. of anhydrous silicate per 600.6 g. acid	Av. final temp., °C.	Av. corr. rise, °C.	Av. heat capacity, 19° cal.	Av. heat of decompn. at 20°, 19° cal./g.	Variation of extremes from av., cal./g.
β -2CaO.SiO ₂ "A"	4	3.0065 ^a	20.2	2.0605	519.3	356.0	+0.5 —0.3
β -2CaO.SiO ₂ "B"	4	2.8955 ^a	20.1	1.9645	519.3	352.3	+0.9 —0.8
γ -2CaO.SiO ₂ "A"	10	2.9480 ^b	20.0	1.9702	519.6	347.2	+1.7 —1.2
3CaO.SiO ₂ "A"	5	2.2195 ^c	20.1	2.0054	519.3	469.2	+1.9 —1.5
3CaO.SiO ₂ "B"	4	2.2137 ^c	20.2	1.9940	519.3	467.8	+0.8 —0.8

^a Ignited samples. ^b Samples corrected for loss on ignition. ^c Samples were ignited for thirty minutes at 800 to 900 deg. Tests for free lime were negative except in two cases where traces were present after ignition. See Carlson, Bur. Standards J. of Res., 7, 893 (1931).

TABLE III—HEATS OF DECOMPOSITION OF DICALCIUM SILICATE AND TRICALCIUM SILICATE IN HCl.200H₂O

Description of sample	Av. heat of decompn. in HCl.20H ₂ O cal./g.	Av. wt. of HCl.20H ₂ O per gram silicate	Av. rise of temp in dilution experiment final soln., °C.	Av. heat of diln. of initial HCl.20H ₂ O ^a to HCl.200H ₂ O, cal./g. of silicate	Av. heat of diln. of final soln., ^b cal./g. of silicate	Calcd. heat of decompn. of silicate sample in HCl.200H ₂ O, cal./g.	Calcd. heat of decompn. of pure silicate in HCl.200H ₂ O, cal./g.
β -2CaO.SiO ₂ "A"	356.0	199.8	0.1483	278.1	273.0	350.9	347.5
β -2CaO.SiO ₂ "B"	352.3	207.4	.1483	288.7	283.4	347.0	346.5
γ -2CaO.SiO ₂ "A"	347.2	204.0	.1483	283.9	278.7	342.0	341.0
3CaO.SiO ₂ "A"	469.2	270.6	.1481	376.6	369.1	461.7	467.5
3CaO.SiO ₂ "B"	467.8	271.3	.1481	377.6	370.0	460.2	467.5

^a 61.22 g. HCl.20H₂O diluted to HCl.200H₂O (total heat cap. 564.2 cal./g.) gave average rise of 0.1510 deg.

^b 61.44 g. of final solution used. Total heat capacity 564.3 cal./g.

cium silicate. It has been shown¹³ that tricalcium silicate is unstable and decomposes into lime and dicalcium silicate at temperatures between 1,000 and 1,300 deg. Tricalcium silicate is metastable with respect to calcium oxide and dicalcium silicate at 20 deg.

Summary

1. A new method for the preparation of the β -form of dicalcium silicate is described.

¹³ Carlson, Bur. of Standards J. Research, 7, 893 (1931).

cate is described.

2. The isothermal heats of decomposition of samples of β - and γ -dicalcium silicate and tricalcium silicate in HCl.20H₂O were determined and the heats of decomposition of the same substances in the pure state in HCl.200H₂O were calculated.

3. The following thermochemical quantities were calculated: (a) the isothermal heats of formation at 20 deg. of β -dicalcium silicate, γ -dicalcium silicate and tricalcium silicate

from calcium oxide and silica gel; (b) the isothermal heats of formation at 20 deg. of tricalcium silicate from calcium oxide and the two above forms of dicalcium silicate; (c) the heat of transition at 20 deg. of β -dicalcium silicate to γ -dicalcium silicate.

4. The results indicated that at 20 deg. β -dicalcium silicate is metastable with respect to γ -dicalcium silicate and tricalcium silicate is metastable with respect to calcium oxide and both the forms of dicalcium silicate.

Compound Mills

(Continued from page 43)

put is reduced. The thickness of the cushioning material between grinding media and mill plates is less, and there is more working of iron against iron whereby more heat is generated. The temperature may thereby rise to 200 deg. C., with the result that a proportion of the water of crystallization of the added gypsum will be given up. Since the resulting anhydride has no effect on setting time, the above effect is simply explained.

The grinding mills used for cement are chiefly ball, tube, and compound mills; the two former are generally used with separating devices, and are complementary to each other. More rarely the centrifugal mill is employed, or a form of preliminary mill combined with suitable screening arrangements or with a tube mill behind it.

Since grinding costs are one of the chief factors in cement production it is important to operate the mill at maximum capacity. This may be done by determining the most favorable speed of revolution, the best type and size of grinding media, the best charge of grinding media and clinker, the best period for the material to remain in the various compartments of the compound mill, or the best time for the material to pass from one machine to another in the case of mixed grinding. The conditions vary widely in different cases, and to determine them the grinding curve of the mill must be drawn; this is obtained by the sieve analysis of samples taken at frequent intervals along the mill. The mill conditions are then varied until the curve falls uniformly along the length of the mill.

Adjust Compartment Lengths

Fig. 1 shows the grinding curve for a compound mill 11 metres long. It

will be seen that the grinding effect is excellent in the first 8 m. of the mill, but that the end 3 m. contribute nothing. To improve matters in this case the first and second compartments, which are at present doing almost all the work, should be shortened, and the third compartment divided into two; the new third compartment should contain somewhat coarser grinding media, and the fourth compartment somewhat finer media. That the first two compartments will stand shortening is shown by the extent to which grinding is driven in these chambers, which proves that they are not completely used but run partly empty, causing excess wear due to the working of iron on iron. The suggested division into four compartments results in the grinding curve of Fig. 2, which shows that the mill is now uniformly used for grinding along its whole length, which is the basic condition for rational grinding.

Men and Mills

[News of and for
Cement Mill Men]

A clearing-house page for all kinds of news about cement men and cement mills. ☐ Readers in all mills, even though not regular contributors, are invited to

send in news notes about personal and plant activities that may be of interest or value to the men in other mills.

The *Manitowoc Portland Cement Company*, Manitowoc, Wisconsin, is preparing to rebuild some docks along the river.

Santa Cruz Portland Cement Co., San Francisco, voted a dividend of 50 cents a share for the quarter.—*Chicago Journal of Commerce*.

International Cement Company, New York City, declared a dividend of 25 cents payable March 29 to stock of record March 11.—*Springfield, Mass., News*.

Fred H. Rhodes, secretary and treasurer of the *Monarch Cement Company*, was elevated to the presidency by stockholders at the annual meeting at Humbolt on February 13. He succeeds the late W. A. Wolf.—*Coffeyville, Kans., Journal*.

Report of *North American Cement Corp.* for the year ended December 31, 1934, certified by independent auditors, shows net loss of \$138,840 after taxes, interest, depreciation, depletion, and other deductions, comparing with net loss of \$742,340 in 1933.—*Wall Street Journal, New York*.

Workmen at the *Lone Star Cement Company's* plant at Limesdale, near Greencastle, Indiana, are now engaged in dismantling one of the huge kilns for shipment to the Rio de Janeiro, South America, plant of the company.—*Brazil, Ind., Times*.

Bessemer Limestone & Cement Co. has been awarded a contract for furnishing 300,000 barrels of cement for the Tygart Dam on the Monogahela River in West Virginia.

Shipments will be spread over about two years.—*Youngstown, Ohio, Vind.*

Coplay Cement Manufacturing Company and Subsidiaries—For 1934: Net income after depreciation, depletion, interest and other charges, \$18,592, equal to \$1.89 a share on 9,827 6 per cent preferred shares, compared with net loss of \$108,278 in 1933.—*New York Times*.

The *Riverside Cement Co.*, Los Angeles, showed net earnings of \$505,149.05, for the year ended last December 31, com-

pared with \$401,042 in 1933. The annual report to stockholders was issued on February 27 by John Treanor, president.—*Washington, D. C., Post*.

Senator White, Rep., of Maine, and the Birmingham (Alabama) Chamber of Commerce have protested to Francis Sayre, chairman of the President's Tariff Policy Committee, against a reported recommendation to reduce the existing duty on portland cement.

The *Pennsylvania-Dixie Cement Corporation* has announced the appointment of Paul J. Rutan to the position of District Sales Manager of the Rochester, N. Y., office, succeeding H. C. Carpenter, who has been transferred to general sales in New York.

Pennsylvania-Dixie Cement Corporation and subsidiaries report for the year ended December 31, 1934, certified by independent auditors, profit of \$1,227,634 before depreciation, depletion and interest, against profit of \$279,223 in 1933. After provision for depreciation, depletion and interest, there was a net loss for year 1934 of \$691,920, against loss of \$1,674,739 in preceding year.—*Boston, Mass., Her.*

Lehigh Portland Cement Co. reports for year ended December 31, 1934, net profit of \$849,155 after taxes, depreciation, depletion and obsolescence, equal to \$5.70 a share (par \$100) on 148,854 shares of 7 per cent preferred stock outstanding at the end of year, and on which there is an accumulation of unpaid dividends. This compares with net loss of \$847,420 in 1933.—*Wall Street Journal*.

Alpha Portland Cement Company's, Manheim, W. Va., plant has a contract for cement which will keep it busy 12 months a year for two or three years as the result of the award of half of a Government contract to furnish cement for the Tygart Valley dam in West Virginia, a flood control project.

The contract was awarded to three companies, Medusa, Bessemer, and Alpha.—*Easton, Pa., Exp.*

The plant of the *Three Forks Portland Cement Company* at Trident, Montana, started up in full swing on March 1, with over 100 men.

B. J. Latmir, superintendent, says the run will be for the production of cement principally for the Fort Peck dam, and enough orders are in sight to insure the rest of the year's work.—*Manhattan, Montana, American*.

At the stockholders' meeting of the *Trinity Portland Cement Company*, Dallas, Texas, held the week of February 11, the following officers and directors were elected: John L. Senior, president and general manager; James F. Hayden, vice president and sales director; G. W. Storey, Chicago, vice president; Raymond T. Gunderson, Canyon, Minn., secretary; Howard Miller, Chicago, treasurer; Samuel L. Wright, Hollywood, Cal., Martin T. Gunderson, Canyon, Minn.; John W. Miner, Jackson, Mich.; D. T. McKone, Jackson, Mich., and R. N. Cowham, Chicago, all directors.—*Dallas, Texas, News*.

Dictionary of Cement in Four Languages

INTERNATIONAL DICTIONARY OF CEMENT, consisting of translations in four languages. Published by Concrete Publications, Ltd., London, S. W. 1, England. Cloth binding, 68 pages, 6 by 9 in.

Technical words and terms used in the manufacture, testing and chemistry of cement and allied subjects are given in alphabetical order in each of four languages—English, French, German and Spanish. The entire work was compiled by cement specialists in England, France, Germany and Spain. The book also contains tables of conversion factors from metric to English and from English to metric, for units in every-day use in the cement and allied industries and laboratories.

This useful volume enables cement manufacturers, chemists and testers to study the cement literature of the world. Copies may be obtained through the Book Department of CONCRETE, 400 W. Madison St., Chicago, at \$2.50 each.

MILL EQUIPMENT

P & H-Hansen is a new 50-amp. vertical welder manufactured by the Harnischfeger Corporation of Milwaukee.

The outstanding feature is said to be the extremely stable high-speed arc which enables it to weld quickly and efficiently down to 26-gauge steels.

The P & H-Hansen W50-254 (15 in. wide and 36 in. high) is supplied with base for stationary mounting or with wheels or lifting bail for easy handling around the shop.

TRAIL-CARS are announced by the Austin-Western Road Machinery Co., Aurora, Illinois.

The Austin-Western Trail-Car (in 8 to 25-ton sizes) is a semi-trailer for use with the short-coupled truck tractor.

Engineered for maximum pay-load operation, they say, these cars (on rubber tires) have features similar to those employed by recognized builders of railroad dump cars. Equipped with bottom or side dump doors that operate by air, hydraulic or mechanical (manual) controls, A-W. trail cars come in three standard body designs, including special, built-to-order constructions.

Features include, they say, a full universal, gravity-cushioned fifth wheel for rough surface travel without strain or distortion; generous ground clearance for easy dumping; low overall height for quick, convenient loading; dumping controlled by truck driver from cab; short turning radius with ample clearance; massive, semi-elliptic springs, mounted directly under center sills; automatic safety dumping devices, etc.

THE ISOMETER, an interesting new development in flow meters, has been taken over by the Elgin Softener Corporation, Elgin, Illinois. This instrument, which uses a variable orifice principle of operation for the measurement of steam, water, oil, and

other liquids and gases, was developed by the Isometer Corporation, of Milwaukee. This organization will now be operated as a division of the Elgin Softener Corporation.



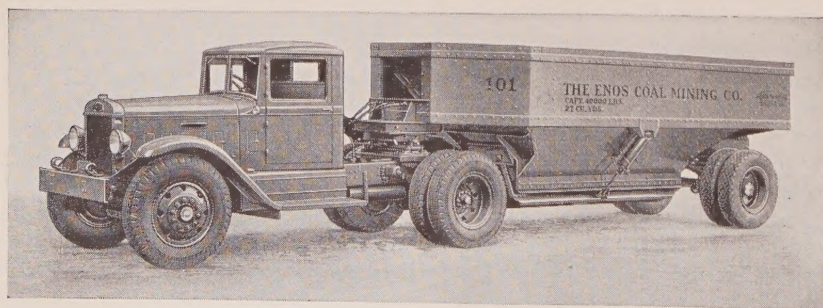
P & H-Hansen vertical welder

Industrial Literature

CALYX Core Drills—Holes up to 72 in. in diameter and 50 ft. deep can be drilled with the Calyx core drill, and the cores removed for study. Smaller holes (with their cores) up to 11½ in. in diameter and as deep as 2500 ft., can be produced.

The Calyx core drill is described very completely and the results of its work is illustrated fully in a new 48-page bulletin just off the press. (Form 9501.)

LINK-BELT'S Silverstreak silent chain drive is presented in terms of what it has done and can do for users in a highly pictorial 32-page book No. 1425, recently released.



The Austin-Western Trail-Car

Industrial Literature

MINOGUE AGITATOR for the Cement Mill is the title of a new four-page folder being distributed by the Manitowoc Engineering Works, Manitowoc, Wisconsin.

The agitator has been developed and patented by R. E. Minogue, assistant superintendent of the Manitowoc Portland Cement Company in co-operation with the Manitowoc Engineering Works. Over eighty units, they say, are in use at this time. Complete agitation of the slurry, low power requirements and low air consumption are reasons given for the success of this equipment.

SOUTHWARK-EMERY 75,000-lb. hydraulic compression testing machine is a recent development in cement and concrete testing equipment, designed and built by the Baldwin-Southwark Corporation of Philadelphia, they say, to exactly meet the requirements of the Working Committee on Plastic-Mortar Tests of the A. S. T. M. Bulletin No. 88 pictures and describes this equipment.

KENNEDY pneumatic transport system for handling bulk cement by railroad car, motor truck, barges, etc., is described fully in a recent folder being distributed by the Kennedy Van Saun Manufacturing and Engineering Corporation of New York City.

CLASSIFIED ADVERTISEMENTS

USED EQUIPMENT

CEMENT MILL EQUIPMENT BARGAINS

- 2—NEW ALLIS CHALMERS 9½'x8'x40' COMPEB MILLS
- 2—REEVES ROTARY KILNS 8'x125'
- 4—TUBE MILLS—5'x22'
- 2—KOMINUTERS 85"x8'
- 1—MARION 460 ELECTRIC CATERPILLAR SHOVEL
- 1—MARION 480 STEAM CATERPILLAR SHOVEL

CRUSHERS, DRYERS, COMPRESSORS AND MOTORS

The above equipment at attractive prices for immediate sale

IRON & STEEL PRODUCTS, INC.

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